OSTRACODS OF THE MÓJČZA LIMESTONE

EWA OLEMPSKA


82 ostracod species, belonging to 51 genera, included in three orders (Beyrichiocopa, Platycop a and Podocopa) from the Ordovician Mójčza Limestone at its type locality at Mójčza (Holy Cross Mountains) are described, 6 genera and 39 species being new. Only a few species are shared by the Holy Cross Mts and Baltoscandian ostracod faunas. Most of genera from Mójčza are known from Baltoscandia, some occur also in Ibero-Armorica, the British Isles and Bohemia. Phosphatized ostracod valves occur in Mójčza in carbonate sediments probably deposited in a stable environment with very slow sedimentation rate. Diversity of the assemblages is generally high and rather stable in time especially in the Middle Ordovician. It is somewhat lower in the basal part of the sequence, gradually increases during the Llanvirn and Landeilo, then strongly decreases in the early Caradoc while increasing again in the middle Caradoc. Biometrical population studies of morphologic evolution demonstrated that larger elements of shell ornamentation (such as crests or spines) were subject to evolutionary changes while the microornamentation remained unchanged; microornamentation is stable also in the ontogeny. The Mojczella lineage is the best example of smooth acceleration in ontogenetic expression of the junction of crest C1 and C3, which originally were separated throughout the ontogeny. Probably environmentally controlled variation in size of carapaces in time has been shown for several species. The pore canals in walls of the Ordovician ostracods and special morphological features, which are believed to have functioned for buoyancy control, are described. Morphology of the tubulous velar structure is described.

K e y w o r d s: Ostracoda, biostratigraphy, evolution, palaeoecology, variation, shell structures, Ordovician, Holy Cross Mts, Poland.

Ewa Olempska, Polska Akademia Nauk, Instytut Paleobiologii, 02-089 Warszawa, Al. Zwirki i Wigury 93, Poland. Revised version received 5th June, 1993.
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The following monograph presents the results of a study of the latest Early, Middle and early Late Ordovician Ostracoda from the Holy Cross Mountains of Poland. The faunas come from the eight meter thick stratigraphically condensed Mójczka Limestone exposure in a quarry on Skala hill at Mójczka, near Kielce. This area is a part of the Małopolska Massif (see Dzik and Pisera 1994, Pl. 1, Text-figs 1–3).

The highly condensed Ordovician strata exposed there range in age from the conodont Amorphognathus variabilis Zone, Arenig-Llanvirn boundary beds (early Kundan Stage), to the Amorphognathus ordovicicus Zone, early Ashgill (Dzik 1990; Dzik 1994). According to Dzik (1989, 1994) there is a sedimentary break about 1.5 m above the base of the section, corresponding to the late Kundan and early Lasnamagian Stages, i.e. the conodont Eoaplacognathus suecicus Zone and E. foliaceus subzone of the Pygodus serra Zone. This gap was probably a result of submarine erosion (Dzik and Pisera 1994).

In the basal part of the section, calcareous sandstone of the A. variabilis Zone is exposed, followed by bisparite passing upward into argillaceous biomicrites with shaley intercalations.

The conodonts from the Mójczka limestones were studied also by Spasov and Teller (1963), Bednarczyk (1966, 1971) and Bergström (1971). Recently, the existing information on the Ordovician of the Małopolska Massif was summarized by Dzik (1983, 1989, 1994), Dzik and Pisera (1994), and the Dzik (1994) stratigraphical classification is followed here.

In contrast with Baltoscandia (Estonia, Latvia, Lithuania, St. Petersburg area, Sweden, Norway), Ibero-Armorica and the British Isles where ostracod faunas are sufficiently well documented (cf. Vannier, Siveter and Schallreuter 1989), in Poland they are very poorly known. Recently, Sztejn (1985) began research on Ordovician ostracods of NE Poland (the SW margin of the East European Platform). The following is the first descriptive study of the Ordovician ostracods of the Holy Cross Mountains.
The work was carried out at the Institute of Paleobiology of the Polish Academy of Sciences, Warsaw (abbreviated ZPAL), where the material is housed (coll. n. O.XXV).

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SEM photographs were taken at the Electron Microscopy Laboratory of the Nencki Institute of Experimental Biology, Warsaw.

Figures were drawn by Mrs. D. SLAWIK (Institute of Paleobiology, Polish Academy of Sciences, Warsaw).

MATERIALS AND METHODS

Samples (0.5–2 kg) were taken for the study at close intervals, each being about 10 cm in thickness. Of these, ostracods were studied from 69 samples. They were extracted from limestones with dilute acetic acid. Specimens are preserved as phosphatic coatings of originally calcitic valves. A free space corresponding to the dissolved calcite wall of the valve can be seen between the outer and inner phosphate layers (Text-fig. 12a). The pore canals within the valves have also been cast in phosphate.

The collection yielded a total of about 8000 specimens. Ostracod shells are most commonly preserved as separate valves. In the Lower Ordovician (A. variabilis Zone) part of the section, ostracods are rather rare. Many specimens are fragmented. The assemblages of ostracods from the upper part of the Llasnámagian and Uhaku Stages are the richest and best preserved of all those considered in the monograph. The microborings bearing valves occur in this part of the section in organodetrital limestones (see OLEMPSKA 1986). These assemblages are rich in juvenile specimens as well as species with small adult shell size. Large adult specimens (over 2 mm) are rare and preserved as shell fragments.

Phosphatic linings of ostracod shells occur throughout the lower 2/3 of the section up to the base of the Ashgill. In the uppermost part of the sequence, in argillaceous biomicrites of the Zalesie Formation, ostracod shells were not covered by a phosphatic coat and it was not possible to extract them from the rock. The samples from this part of the section are not included in this study. The state of preservation of the ostracods was highly variable. Some of the specimens were very well preserved with easily identifiable details of microornamentation, while others, represented especially by metacopids, were preserved mostly as moulds. Because of the state of preservation, the structure of hinges and other details of internal morphology were not studied.

Heteromorphs have not been identified in all species expected to display sexual dimorphism.

STRATIGRAPHICAL DISTRIBUTION OF THE OSTRACODS

The stratigraphy of the Mójcza Limestone is based mainly on conodonts (DZIK 1978, 1990, 1994) which enables relatively precise dating of the ostracod assemblages. Text-fig. 1 and Tabs 1–3 summarize the biostratigraphy of Arenig to Ashgill ostracod faunas from the Mójcza Limestone.
**Figure 1.** Vertical distribution of ostracod species in the Megaza section.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Species</th>
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<tbody>
<tr>
<td>Arenig</td>
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<td>Llanvirn</td>
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<td>Llansile</td>
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<td>Caradoc</td>
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<td>Ashgill</td>
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<td>Lahin</td>
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<td>Llandilo</td>
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<td>Johvi-Nabal</td>
<td>Poruk</td>
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</table>
### Ostracods of the Moicza Limestone

<table>
<thead>
<tr>
<th>Arenig</th>
<th>Llanvirn</th>
<th>Llandeilo</th>
<th>Caradoc</th>
<th>Ashgill</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>KUNDA</strong></td>
<td><strong>LAS</strong></td>
<td><strong>UHAKU</strong></td>
<td><strong>KUKRUSE</strong></td>
<td><strong>IDAVERE</strong></td>
</tr>
<tr>
<td>Anomoplagnothius variabilis Zone</td>
<td>Pygoda asseriensis Zone</td>
<td>Anomoplagnothatius tavaresis Zone</td>
<td>Anomoplagnothatius superbis Zone</td>
<td>A. ordovicianus Zone</td>
</tr>
</tbody>
</table>

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**Fig. 1.** (continued)
Many of the ostracods in the Mójcza Limestone show extended stratigraphic ranges which reflect their fairly slow evolution, especially in the Middle Ordovician. Nevertheless, some of them do have restricted ranges and can be used as marker species.

**EARLY ORDOVICIAN OSTRACODS**

The studied interval ranged from 4.3 to 2.85 m below the bentonite layer. It is represented by sandy biomicrites of the conodont *Amorphognathus variabilis* Zone. The ostracod assemblage comprises 28 species (Text-fig. 1, Tab. 1). A majority of them are new taxa. In the basal part of the section 4.3 m to 3.6 m below the bentonite (samples MA-117 to MA-38) the ostracod assemblage is rich and diverse (24 species). Unfortunately, most of the palaeocope species are broken into fragments. The Mójcza lineage appears in the Mójcza section close to its base (*M. polonica*) and continues throughout much of the section (see OLEMPSKA 1989).

The species most widely represented in the lowest part of the *A. variabilis* Zone are *Lembitsarvella* sp., *Laccochilina* (L.) *berdanae* sp. n., *Mojczella* *polonica* OLEMPSKA, *Otraczetia bulbata* gen. et sp. n., *Hesslandella sztejnae* sp. n., *Rakverella* (P.) *antica* sp. n., *Collibolbina barbarae* sp. n., *Glossomorphites* (G.) *kielcensis* sp. n., *Unisulcopleurra reticulata* sp. n., *U.? permulta* sp. n., *Conchoprimitia? modlinskii* sp. n., *C.? polonica* sp. n., *C.? ventroincisurata* HESSLAND, and *Klimphores* (Laterophores) *ansiensis* GAILITE. Numerous specimens of *Medianella*, identified however only to the generic level, are also present. Of this assemblage, only *C.? ventroincisurata* and *K. (L.) ansiensis* have been recorded in the Lower Ordovician of Baltoscandia. *C.? ventroincisurata* has been found in the Lower Ordovician deposits of Siljan District in Sweden (HESSLAND 1949), it is limited to the lower part of the “G” layer (lower part of the Kundan Stage, its Hunderumian and Valastean Substages). *K. (L.) ansiensis* in Latvia was found in the sediments of the Kundan Stage (GAILITE 1971). In the samples representing the upper part of the *A. variabilis* Zone (samples MA-126 to MA-41), *Pinnatulites procera* (KUMMEROW) appears and is an important marker for this level in Mójcza. *P. procera* was described (HESSLAND 1949) from the upper part of the “G” layer in Siljan District of Sweden (Kundan Stage – Valastean Substage). In northern Estonia, *P. procera* has been found in the B IIIβ and B IIγ substages (SARV 1959), in the same substages in Latvia (GAILITE and ULS 1972; MÄNNIL 1966) and Lithuania (SIDARAVCIENĖ 1976, 1992). In addition to the *P. procera* in these samples, *Gryphiswaldensia angustivelata* sp. n., *Eochilina?* sp. and *Uhakiella* sp. make their appearance. About 1.5 m above the base of the limestone section there is a sedimentary break corresponding to the Late Kundan and Early Lasnamägian Stages. At the discontinuity surface species of *Conchoprimitia*, *Glossomorphites*, *Rakverella*, *Ogmoopsis*, *Pinnatulites* and *Laccochilina* disappear.

A number of genera such as *Klimphores*, *Collibolbina*, *Mojczella*, and *Lembitsarvella* continue their evolution in the Middle Ordovician sediments, and new species appear there which are undoubtedly related to those in the Lower Ordovician. *K. (L.) ansiensis* is the only species that ranges into overlying *Pygodus serra* Zone.

**MIDDLE ORDOVICIAN OSTRACODS**

The *Pygodus serra* Zone deposits are represented by organodetrital limestones (samples MA-42 to MA-58). Just above the discontinuity surface, numerous new taxa of ostracods appear (Text-fig. 1, Tabs 1, 2). This assemblage consists predominantly of the palaeocope species *Lembitsarvella polonica* sp. n., *Swantina schallreuteri* sp. n., *Gryphiswaldensia cavata* sp. n., *Euprimites grandis* sp. n., *Uhakiella diuturna* sp. n., *Piretia speciosa* sp. n. and *Collibolbina postaculeata* sp. n. All these species are long-ranging and of limited value for age definition. The *Mojczella* lineage is represented here by *M. jaanussoni* OLEMPSKA, appearing in this part of the section and passing higher up (see OLEMPSKA 1989). At the base of the *P. serra* Zone, *Primitiella mojczensis* sp. n. makes its appearance and occurs in great numbers. *Sigmobolbina lysicae* sp. n., *Vogdesella aequae* sp. n. and *Pseudorayella ovalis* *NECKAIA* are resticted to the lower part of the *Pygodus serra* Zone and are thus important markers for this part of the section. *Domaszeczicella tridepressa* sp. n. disappears close to the uppermost sample of the *Pygodus serra* Zone.
In the overlying deposits (samples MA-45 to MA-46), Piretia tenuistriata sp. n., Orechina krutai sp. n. and Lubrzankiella minuta sp. n., Hesperidella posterospinata sp. n., Piretia amphi cristata sp. n., Medianella? pudica sp. n., and ostracods identifiable only to generic level (Uhakiella, Hippula) make their appearance.

In the middle part of the P. serra Zone, Condomyra reticulata SCHALLREUTER makes its appearance, known until now only from Upper Ordovician Öjlemyrflint erratic boulders (SCHALLREUTER 1968b, 1986). Its range in the Möjczca Limestone corresponds to a part of the Uhakuan, Kukrusean, and Idaverean Stages. Another important species appearing in the same part of the sequence (sample MA-47) is Ceratobolina monoceratina (JAANUSSON), restricted to the Uhakuan and Kukrusean Stages in Baltoscandia (JAANUSSON 1957; SARV 1959). In Möjczca only tecnomorphic valves of this species have been found. In the upper part of the Pygodus serra Zone, Piretella oepiki THORS LU ND makes its appearance. In Möjczca it is a long ranging species (up to the Amorphognathus superbus Zone), in Baltoscandia P. oepiki is restricted (THORS LU ND 1940) to the upper Chasmops series (late Caradoc). Taxonomically, the upper part of the P. serra and the lower one of Pygodus anserinus Zones are fairly similar in composition.

No significant faunal change was connected with the bentonite deposition. Above the bentonite layer (samples MA-67 to MA-83) in the upper part of the Pygodus anserinus and the lower part of Amorphognathus tvaerensis Zones, the ostracod assemblage is less rich and diverse compared to that of the P. serra and the lower part of P. anserinus Zones.

The assemblage of the A. tvaerensis Zone consists predominantly of a metacope Medianella? pudica sp. n. and Longiscula? affluens sp. n. Palaeocopes disappear in this Zone or are very rare. In the middle part of the A. tvaerensis Zone (sample MA-76), Gryphiswaldensia gryphiswaldensis SCHALLREUTER makes its appearance. According to SCHALLREUTER (1975a) this species is common in Backsteinalk erratic boulders (lower Upper Viruan). In the upper part of the A. tvaerensis Zone, 1.1 m above the bentonite layer (samples MA-83 to MA-85) palaeocopes Lemibitarvella polonica sp. n., Gryphiswaldensia cavata sp. n., Uhakiella diuturna sp. n., Swantina schallreuteri sp. n., and Collibolina postaculeata sp. n. reappear abruptly. The upper boundary of the A. tvaerensis Zone is not crossed by G. cavata, L. polonica, and U. diuturna, the last two named species reappear higher.

The most significant ostracod in the A. tvaerensis Zone is Mojczella sanctacrucensis OLEMPSKA, the end-member of the Mojczella evolutionary lineage. In the upper part of the A. tvaerensis Zone, Vaivanovia hiddenseenis SCHALLREUTER makes its appearance, described by SCHALLREUTER (1966) from Backsteinalk erratic boulders (lower Upper Viruan). Taxonomically, the upper part of the A. tvaerensis Zone and lower part of the Amorphognathus superbus Zone (samples MA-84 to MA-93) are fairly similar in composition to the strata below in the section.

LATE ORDOVICIAN OSTRACODS

A significant change in the composition of ostracode species took place in the upper part of the A. superbus Zone (sample MA-99, Text-fig. 1, Tab. 3). A number of species make their appearance: Trianguloschmidella (Rempesgrinella) hemiventricosta (KNÜPPER), Rectella carinaspinata SCHALLREUTER, Klimphores (K.) vannieri sp. n., Bromidella sp., Steusloffinla sp. R. carinaspinata was described by SCHALLREUTER (1972) from Öjlemyrflint erratic boulders (Upper Ordovician).

Sediments which represent the Amorphognathus orдовicus Zone (samples MA-100 to MA-116) contain a rich fauna of ostracods, but it was not possible to extract them from the rock.

AFFINITIES OF THE MÓJČZA OSTRACODS

The comparison between the ostracod assemblages of three major Ordovician palaeogeographic domains of Europe: Baltoscandia, Ibero-Armorica and the British Isles, and that of the Holy Cross Mountains Ordovician ostracod assemblages, shows that they are different with regard to specific
<table>
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Fig. 2.
Ordovician (Arenig-Ashgill) genera common between Holy Cross Mountains and Baltoscandia, British Isles and Ibero-Armorica. Data from the three latter regions after VANNIER et al. (1989).

content, but have many genera and subgenera in common. Recently, the existing information on the Ordovician ostracods in these palaeogeographic regions was summarized by VANNIER et al. (1989). Over 250 ostracod genera have thus far been recognized in Ordovician ostracod faunas of Baltoscandia, the British Isles, Armorica (see VANNIER et al., 1989), and Bohemia (SCHALLREUTER and KRŮT 1988). They represent four orders (Beyrichiocopa, Platycopia, Leperditicopa, Podocopa) and are subdivided into over 50 families. Ordovician ostracods of Europe, and especially those of the Baltic region, show substantial differentiation at all taxonomic levels. Palaeocopes and binodicopes represent 85% of all genera. A palaeocopid domination increases from the Ibero-Armoric Massif through the British Isles and reaches its maximum in the Baltic region (VANNIER et al. 1989). According to these authors, the most extensive generic similarities are between Baltoscandia and the British Isles in the Late Ordovician.

The ostracod generic links most clearly occur between the Holy Cross Mountains and Baltoscandia. These regions have 42 genera in common (Text-fig. 2). Palaeocopes and binodicopes represent the dominant components in these regions.

The Early Ordovician palaeocope fauna of the Holy Cross Mountains and Baltoscandia possesses 9 genera in common (53%); 5 palaeocope genera, one binodica (Klimphores), one eridostracan
OSTRACODS OF THE MÓJCZA LIMESTONE

(Conchoprimitia) and two metacope genera (Pinnatulites, Medianella). Differences in the character of ostracod assemblages between Baltoscandia and the Mójcza section of the Malopolska Massif, are mainly expressed by the absence in the Holy Cross Mountains of a number of genera very characteristic of Baltoscandia. In the Early Ordovician, such characteristic genera as Aulacopsis, Tallinella, Tallinellina, Piretopsis, Protallinella and many others do not occur in the Mójcza Limestone.

The Kundan ostracod assemblages in Baltoscandia along with Pinnatulites are dominated by species of Conchoprimitia. A few species of Conchoprimitia are found in Mójcza, represented mostly by new species. The Early Ordovician ostracods from other regions are poorly documented, the lack of information being related to lithological factors, e.g. coarse-grained deposits in Ibero-Armorica (see VANNIER et al. 1989).

In the Middle Ordovician, the Holy Cross Mountains and Baltic ostracod faunas show strong similarities at the generic level. These regions have 27 ostracode genera in common in the Middle Ordovician; 15 palaeocene genera, 6 binodicope genera, one leiocone, two platycope genera and 3 metacope genera. Many palaeocene genera important in Baltoscandia such as Steusloffia, Tetrada, Tetrabella, Oepikella, Chilobolbina, Laccochilina, Tallinella, Polyceratella, and others are absent in the Holy Cross Mountains Middle Ordovician deposits. Generic affinities exist in the Early and Middle Ordovician with Sweden or Estonia as well as north-eastern Poland, which belongs to the East European Platform. Ordovician ostracods in NE Poland are of the Baltic type, being particularly close to those of Lithuania and Latvia (SZTEJN 1985). There are no species in common with the Holy Cross Mountains there. Two palaeocene genera (Euprimites, Vittella), two binodicope (Klimphores, Vogdesella), one platycope (Primitiella), and one metacope (Medianella) are also common to the Holy Cross Mountains and Ibero-Armorica in the Middle Ordovician. Generic affinities between the Holy Cross Mountains and the British Isles are not numerous, four genera being in common in the Middle Ordovician (Duringia, Vittella, Klimphores, and Vogdesella). The Ashgillian ostracod fauna is only partly documented in the Mójcza section. There are some differences between the Holy Cross Mountains and Baltoscandian ostracod faunas in the Ashgill. Binodicopes and metacopes are relatively much more important components in the Holy Cross Mountains and palaeocopes are relatively less important than in Baltoscandia. These two regions have 11 ostracode genera in common in the Ashgill; 5 palaeocopes (Platybolbina, Swantina, Piretella, Gryphiswaldensia, Bromidella), two binodicopes (Klimphores, Orechina) and four podocope genera (Rectella, Trianguloschmidtella, Steusloffina and Medianella). The Ashgill is characterized by very low generic affinities between the Holy Cross Mountains and Ibero-Armorica and the British Isles. The Holy Cross Mountains and Bohemia have only one genus (Orechina) in common in the Late Ordovician (see SCHALLREUTER and KRÚTA 1988).

SCHALLREUTER and SIVETER (1985) analyzed the composition of Ordovician and Silurian ostracod faunas in Europe (southern Britain and Baltoscandia) and North America, on both sides of the Iapetus Ocean. They found many genera common to both of these regions, contrary to the current view about the complete isolation of Ordovician ostracods in both of these areas. The suspected width of the Iapetus Ocean during the Ordovician was about 2000–3000 km (WILLIAMS 1980; MCKERROW, and COKS 1976). SCHALLREUTER and SIVETER (1985) suggest the possibility of a smaller width of the Iapetus Ocean with a smaller depth or presence of “islands”, which eased animal migration.

Ordovician ostracods of the Holy Cross Mountains show weak connections with the ostracod fauna of the North American Midcontinent (Laurentia). Only the Middle Ordovician genera Vittella and Klimphores present in Mójcza are also found in the Llandeilo of South Wales (SCHALLREUTER and SIVETER 1985). Many other genera are missing in Mójcza including Pseudulrichia, Tallinnellina, Cryptophyllus, and others present either in Baltoscandia or in North America (cf. SCHALLREUTER and SIVETER 1985). In the Late Ordovician ostracod faunal connections between the Baltoscandia and North America are substantially stronger. Unfortunately, in the Mójcza Limestone, Late Ordovician ostracods are very poorly preserved and difficult to identify. Rare links exist at the generic level between the Holy Cross Mountains, N-E Asia, and Kazakhstan (KANYGIN 1971; MELNIKOVA 1986).
ENVIRONMENTAL CONDITIONS

The highly condensed Ordovician in the Mójcza section consists predominantly of carbonates, except for sandy deposits in the lower part of the section and marly sediments at the top. In this area the sediments were formed in the sublittoral, shallow neritic environment (Dzik 1976; Suzukiewski 1977; Modliński 1982). For interpretation of relative depth, water energy, intensity of bioturbation, rate of sedimentation etc., the fossil ostracod assemblage may yield useful information.

Ostracods are preserved in the Mójcza section almost exclusively as separate valves instead of closed carapaces, which is suggestive of the low rate of accumulation (Pokorny 1965; Oertli 1971; Adamczak 1981; Guernet and Lethiers 1989). In thin sections perpendicular to the bedding plane, concave-up orientation of the valves, which could have suggested shell resedimentation after a period of turbulence, has not been found. Convex-up orientation of the valves suggesting current effects (Guernet and Lethiers 1989) was also not found. A decisive majority of the valves is found in the "normal" position (partly convex-up, partly concave-up) with a certain amount of the shells in a vertical orientation to the bedding plane. Vertical orientation of ostracod shells suggests interstitial animal activity and sediment mixing (Adamczak 1981). While studying ostracod shell orientation in the sediments of the Silurian of Gotland, Adamczak (1981) observed that the relation of vertically oriented ostracod valves compared with other valve positions (convex-up, concave-up) provides a measure for the intensity of bioturbation. The bioturbation index proposed by Adamczak (1981) could not be objectively calculated in individual thin sections of limestones from Mójcza due to the excess amount of ostracod fragments difficult to orient. The samples do not show any apparent reworking. The absence of mixed conodont (Dzik 1990, 1994) and ostracod faunas as well as the small number of vertically oriented ostracod valves suggest that the depth of bioturbation was very low, probably not exceeding a few centimeters.

In the sediments at the end of the Llandoil the amount of ferruginous ooids in the sediment increases, but the genesis and the environment of ferruginous ooids is still debated (cf. Dzik and Pisera 1994). In this part of the section, ostracod shells serially inserted into one another are often found. This “saucer stack” effect is often observed (Guernet and Lethiers 1989) when a large quantity of shells of one species, usually with a smooth shell surface, are present on the bottom and are slightly but systematically moved by water. This type of environmental energy is present near the banks of lakes and lagoons (Guernet and Lethiers 1989). Bioerosion is also documented in ostracod valves (Olempska 1986).

In the sediments of the Llanvirn, Llandoil, and Caradoc in Mójcza, many species display ornamentation such as reticulation and costation for strengthening the carapace. According to Benson (1975, 1981), Liebau (1977), Peyrouquet (1979), and Becker and Bess (1990) shallow water species in an environment with a favourable chemical gradient for the precipitation of calcite are capable of secreting massive shells with redundant structural elements. More primitive types of ornament were maintained in the quiet waters of the marine deep sublittoral and bathyal zones. Reticulation with equal-sized fossae and high broadened muri present in the species of Klimphores common in the Mójcza sediments, according to Liebau (1977) is an adaptation to protect the pore clusters or to strengthen the shell in turbulent shallow waters. The area of the Mójcza Limestone formation did not represent, however, the marginally shallow littoral sedimentation zone. Periods of weaker and stronger bottom water turbulence with small displacement of a part of the sediments could have been an important feature of the Mójcza limestone sedimentation. It is also possible that it took place close to the zone of “upwelling” currents, which support the rich development of animal life. In zones of such current activity, substantial quantities of phosphates, so characteristic of Mójcza limestones, are present. According to Dzik and Pisera (1994) the deposition of Mójcza limestones took place in an extremely stable environment with very slow sedimentation rate and with a homogenization of the sediment by very shallow bioturbation. The absence of entire macrofossils was caused by their destruction during prolonged period of exposure on the sea bottom and such exposure was also necessary for the origin of phosphatic envelopes (Dzik and Pisera 1994).
OSTRACODS OF THE MÓJCZA LIMESTONE

FAUNAL DYNAMICS OF THE MÓJCZA OSTRACODS

Ostracod faunal dynamics, that is, changes in the composition of ostracod assemblages in time and space with respect to environmental conditions, as reflected in lithology, were analyzed (according to Jaanusson’s 1976 methodology) in the entire Mójcza section beginning with the Kundan up to the Upper Ordovician (sample MA-99). This analysis was biased by the varying state of preservation of the specimens some of which, those without phosphate coating, were lost during chemical preparation.

The number of specimens in a sample was counted and their relative frequency calculated. A quantitative composition of each ostracod sample yielding at least 10 specimens is present in the diagram of relative abundance (Text-fig. 3). Only species that form 10% or more of the total number of ostracods in at least one sample are shown, the remaining are grouped as “others”. Each separate valve was counted as one specimen. Fragmented valves were not counted. No lower size limit was applied. Because only one sequence has been investigated to date, it is difficult to analyze the distribution of assemblages and species of ostracods in relation to lithofacies. It is not always clear which changes were the results of local environmental events, and which depended on interregional factors.

Clear lithologic changes in the Mójcza section are found on the boundary between the Kundan and Lasmamáigian stages, where sandy biosparenetes are replaced by organodetrital limestones. Another significant lithologic change is found at the top of the sequence where argillaceous biomicrites appear.

The lower part of the Amorphognathus variabilis Zone is charactrized by the domination of Uniszulcopleura? permulta sp. n., whose relative frequency varies between 8% and 32% in all samples from this part of the sequence. Conchoprimitia? polonica sp. n. whose relative frequency in this part of the profile varies between 12 and 25% with the exception of sample MA-33, where it achieves 54% of total content, is subdominant. The remaining 25 species which appear in the lowest part of the section do not exceed a few percent of each sample content and six of them, Mojczella polonica, Collibobina barbarae, Hesselandella sztejnae, Klimphores (L.) ansiensis, Uniszulcopleura reticulata and Medianella? sp. appear with a frequency below 15%. Pinnatulites procera appears rather abruptly in large numbers in sample MA-126. At the beginning it constitutes 27–48% of the total content and in sample Ma-40 it achieves about 70% of the contents of the assemblage. As in other areas of the Baltic region, this species disappears completely with the upper Kundan boundary. In Baltoscandia one of the most pronounced changes in the Ordovician carbonate sequences took place at the boundary between the Kundan and Aserian Stages. Many genera disappear in the ostracode fauna at this level (Mannil 1966; Jaanusson 1960, 1976).

The most significant change in the ostracod fauna in the Mójcza section took place at the discontinuity surface. Glossomorphites, Pinnatulites, Rakverella, Conchoprimitia, and Laccochilina characteristic for all of Baltoscandia in the Kundan Stage, disappear completely. In the Mójcza section these genera do not appear again in the upper parts of the section, while some genera such as Conchoprimitia, Laccochilina, Rakverella, and others in the other Baltic areas continue their evolution and are represented by a number of species characteristic of the Middle Ordovician.

The discontinuity surface is associated with a significant turnover in the ostracod faunas, and numerous new taxa appear. The gap at Mójcza corresponds to the basal Viru discontinuity surface in the Baltic area, and terminal Llanvirn regression in Wales and China (cf. Dzik and Pisera 1994). In the lower part of the Pygodus serra Zone the assemblage is dominated by the following three species (with the maximum abundance given in brackets): Primitiella mojczensis (73% in sample MA-42), Klimphores (K.) subplanus (25% in sample MA-45), and Vogdesella aequae (14% in sample MA-43). The upper part of the Pygodus serra Zone is dominated by Longiscula? affluens (44% in sample MA-56) and Gryphiswaldenia cavata (27% in sample MA-51). Specimens of Klimphores (K.) subplanus are also comparatively numerous (19–21% in samples MA-52, MA-54). Numerous palaeoecope species occurring there are present in small numbers. The assemblage from the lower part of the Pygodus anserinus Zone is similar to those in the upper part of the P. serra Zone but are poorer in genera and species.
Fig. 3.
Log of percent frequency for ostracod genera in the Mőjeza section (see text for full explanation).
The most profound ostracod faunal change takes place in the upper part of the *Pygodus anserinus* Zone and the lower part of the *Amorphognathus tvaerensis* Zone (the part of sequence just above the bentonite layer). The ostracod assemblage is characterized by a drastic decrease in the diversity of species. Palaeocope and binodicope species became rare and the metacope *Longiscula? affluens* dominates, occasionally with a frequency of up to 78% (sample MA-74), together with the metacope *Medianella? pudica* (33% in sample MA-71). The faunal change is also expressed here in conodont species diversity (Dzik 1994). This faunal change is not connected with any significant change in the sedimentation regime. This was probably a result of the basal Caradoc transgression, and suggests a warming of the climate (cf. Dzik and Pisera 1994). The assemblage of the upper part of the *Amorphognathus tvaerensis* Zone is characterized by an increase in the relative frequency of palaeocope species, *Lembitsarvella polonica* (up to 23% in sample MA-84), *Gryphiswaldensia cavata* (up to 9% in sample MA-86), *Mojczella sanctacrucensis* (9% in sample MA-87), *Collobilbina sigmoidea* (up to 12% in sample MA-84). This part of the sequence is marked by a decrease in the frequency of metacope species, but they are still dominant forms (*Longiscula? affluens* up to 52% in sample MA-90). New species also appear but are in insignificant quantities.

Ostracod assemblage of the *Amorphognathus superbus* Zone are dominated by the following three species: *Longiscula? affluens* (up to 52% in sample MA-97), *Klimphores (K.) vannieri* (up to 63% in sample MA-96) and *Gryphiswaldensia gryphiswaldensis* (up to 44% in sample MA-91). At sample MA-99, the next change in the ostracod fauna takes place. *Trianguloschmidtella (Rempesgrinella) hemiventrocosta*, *Steusloffina* sp., *Bromidella* sp., *Rectella carinaspinata* make their appearance. They constitute a very small percentage of the assemblage. *Longiscula? affluens* is still the dominant species in this sample (30% of the total content). *Klimphores (K.) vannieri* (24% of the total content) and *Orechina krutai* (14%) are also important components of the assemblage.

The result of the investigations indicate clearly that in the Mójčza Limestone there are major changes in the ostracod fauna primarily at three stratigraphic levels: (1) the discontinuity surface, Kundan-Lasnamägian boundary, (2) upper Kukrusean interval, (3) early Ashgill interval. These levels are also associated with major changes in the fauna of conodonts (see Dzik 1990; Dzik and Pisera 1994).

With reference to the ecological model of Bretsky and Lorentz (1970), Vannier et al. (1989) recognized two main types of Ordovician ostracod faunas: binodicope-rich faunas typically associated with a clastic and unstable environment, such as Ibero-Armorican, and more diversified, palaeocope-rich faunas typically associated with more stable conditions and carbonate sedimentation, such as in Baltoscandia. The Middle Ordovician ostracod fauna from Mójčza belongs to the second type, characterized by a palaeocope-binodicope ratio bigger than 1. This type of paleobiological model of Vannier et al. (1989) refers to stable environmental conditions, high diversity, low frequency, high evolution rates and low persistence of stable community structure and high spatial heterogeneity. Assemblages that can be classified as belonging to this type are recognizable in Mójčza only in Lasnamägian, Uhakuan and early Kukrusean time. In the late Kukrusean and early Ldaverean Stages, the composition of the assemblage changes, but without change in carbonate sedimentation. Metacopes play the dominant role here.

Often, the relative frequency of palaeocopes is higher in extremely shallow water environments than in beds deposited at some depth (Kaesler and Peterson 1977; Jaanunsson 1979). In Recent benthic assemblages, as long as other conditions are constant, species frequency does not vary much beneath 150–250 m of sea depth. Large differences in species frequency within the shelf region do not appear to be depth dependent, but are primarily controlled by factors such as substrate and variety of niches (Jaanunsson 1979). Jaanunsson and Bergström (1980) suggested that temperature, rather than depth, could have been one of the more important factors controlling the distribution of conchoclines in the Ordovician. According to Jaanunsson (1984) the changes in Ordovician benthic associations along environmental gradients (e.g. graptolitic shale to coarse grained sediments) were more substrate-dependent than depth-related, although of course depth remains one of the parameters.

Differences in ostracode diversity and composition of ostracode fauna in Mójčza probably were thus not controlled as much by facies differences as by climatic changes (see also Dzik and Pisera 1994).
BIOGEOGRAPHIC POSITION OF THE MÓJCZA OSTRACODS

The Malopolska Massif, according to data available to date, was the Ordovician area closest geographically and faunistically to the East European Platform (Baltoscandia). These two areas were separated by a belt of deep-sea, possibly oceanic sediments. There was no continuation between the carbonate platforms of these areas (MODLINSKI 1982; DADLEZ 1987; DZIK 1983, 1990; DZIK and PISERA 1994). The problem of distance from the Holy Cross Mountains to the East European Platform in the Ordovician has been the subject of many works. Except for paleomagnetic data, often saddled with a large margin of error, the most significant in this debate are faunistic studies, especially of the benthic faunas. Ostracods described here, except for trilobites and brachiopods are one of the most important groups.

Palaeomagnetic investigations published by LEWANDOWSKI (1987) indicate 60° paleolatitude of the southern hemisphere for the Lower Ordovician Bukówka sandstone from Mójcza. LEWANDOWSKI (1987) suggests a 35-40° paleolatitude gap between East European Platform and the Malopolska Massif, and a 4000 (±2000) kilometers wide ocean between the Platform and the southern part of the Holy Cross Mountains in the Late Cambrian – Early Ordovician time. In his opinion the Holy Cross Mountains area travelled with an averaged velocity of approximately 4 cm/year from a polar province in the Middle/Late Cambrian times, through subpolar latitudes in the Early Ordovician to the equatorial zone at the end of the Silurian. The new paleomagnetic data (LEWANDOWSKI 1993) suggest the translation of the southern region of the Holy Cross Mountains during the Variscan orogeny, on the distance ca. 1000 km, from the recent position of the Crimean Peninsula along the present day East European Platform border.

Studies of Middle Ordovician trilobites, brachiopods and conodonts demonstrate that faunistic differences between the carbonate platform of the Malopolska Massif and the East European Platform were not big enough to support the concept of separation of these regions by a wide ocean or attribution to different climatic zones. DZIK and PISERA (1994) suggest the presence of about a 350 kilometer wide deep zone separating the Malopolska Massif and East European Platform during the Ordovician.

The comparison between the Baltic and Mójcza Ordovician ostracod assemblages shows that they are different in regard to specific content, but yield many common genera. Therefore I suggest that the part of the Tornquist Sea separating the Holy Cross Mountains from Baltica could not be as wide as suggested by LEWANDOWSKI (1987). However, it was probably wider than 100–200 kilometers.

CHRONOMORPHOClines IN THE MÓJCZA OSTRACODS

Quantitative research on intra- and inter-population variability of ostracod species in the Mójcza Limestone has resulted in recognition of several small but significant shifts in the morphology of the carapace over time. It was possible to do this in the case of species with long continuous ranges and in the case of related species, possibly representing a punctuated record of continuous lineages. The study has been focused on changes in the ostracod shell size and ornamentation. A tendency among many species to increase shell size with time and among certain species to “strengthen the shell” by the development of shell surface crests was observed.

The microornamentation shows almost no variation in both ontogeny and phylogeny. No modifications of the lateral outline of the shell have been observed.

VARIATION IN SIZE OF CARAPACE

An analysis was carried out of the variation of 11 ostracod species which are present in the Mójcza section in larger quantities of specimens and for relatively long period of time. Length and height of valves of all moult stages in each population were measured and then shell size distribution in each
Size dispersion of *Gryphiswaldensia cavata* sp. n. Samples MA-42, 43, 45, 46 – lower part of the *Pygodus serra* Zone; samples MA-47, 48, 49 – middle part of the *Pygodus serra* Zone; samples MA-50, 51, 52, 54, 55, 56; samples MA-57, 58, 59 – upper part of the *Pygodus serra* to the lower part of the *Pygodus anserinus* Zone; samples MA-62, 64, 65, 66, 74, 78, 86 – middle part of the *Pygodus anserinus* Zone to the middle part of the *Amphognathus tvaerensis* Zone.
moult stage was compared. Usually a small but significant increase of the size of carapaces in time was observed.

(1) *Grhythswaldensia cavata* sp. n. Measurements were done for 256 specimens from 23 samples (Text-fig. 4). The species is present beginning with the discontinuity surface (*Pygodus serra* Zone) to the uppermost *A. tvaerensis* Zone. Between adult specimens from the *P. serra* Zone (average length 0.75 mm) and *A. tvaerensis* Zone, an increase in average length of about 0.2 mm and height of 0.1 mm takes place. The youngest moult stages are subject to minimal changes. The average shell length of the smallest specimens of *G. cavata* both in the populations derived from sediments of the *P. serra* Zone and derived from the lower part of the *P. anserinus* Zone is about 0.4 mm. In the sediments of the upper part of *P. anserinus* and *A. tvaerensis* Zones the smallest specimens found have a shell length of approximately 0.6 mm. However, because of the small quantity of specimens in these Zones, it is difficult to determine unequivocally which moult stages are and which are not represented.

(2) *Lembitsarvella polonica* sp. n. Measurements of 78 specimens from 14 samples, beginning from the *P. serra* to *A. tvaerensis* Zones, were done (Text-fig. 5). In the upper part of the section, only single specimens were present. They were not considered in biometric studies. The increase in average length of shells of the pre-adult specimens between the populations of this species in the *P. serra* and *A. tvaerensis* Zones is approximately 0.6 mm. The corresponding average height increase is approximately 0.25 mm. In this species accurate measurements of female and adult tecnomorphic valves were not possible because of the significant degree of damage to shells greater than 2–3 mm. *Lembitsarvella* sp., occurring in the lowest part of the sequence (*A. variabilis* Zone) and clearly being very closely
Fig. 6.
Size dispersion of *Piretia tenuistriata* sp. n. Samples MA-46, 47, 48, 49 - lower and middle part of the *Pygodus serra* Zone; samples MA-51, 55 - upper part of the *Pygodus serra* Zone; samples MA-58, 59 - boundary between *Pygodus serra* and *Pygodus anserinus* Zones; samples MA-84, 85 - middle part of the *Amorphogonathus tvaerensis* Zone.

related with *L. polonica*, could not be included in the biometric studies because of a significant amount of shell damage and small quantity of specimens.

(3) *Piretia tenuistriata* sp. n. 53 specimens from 10 samples from the *P. serra* to *A. tvaerensis* Zones were measured (Text-fig. 6). It is one of the longest-ranging species in the Mójcza sequence. The difference in average shell length of the female valves in the *P. serra* Zone (average length 1.5 mm) and the *A. tvaerensis* Zone is 0.2 mm. There is, however, rather significant variability in female shell size within each population, e.g. in sample MA-84 shell length differences among heteromorphs are 0.2 mm.

(4) *Uhakiella diuturna* sp. n. 45 specimens from 13 samples were measured (Text-fig. 7). Here too, a certain tendency of shell size increase over time can be observed. However, the small quantity of female valves in the sequence does not allow an unequivocal evaluation of the changes occurring.

(5) *Mojczeza* lineage. Length and height measurements of shells of three species of *Mojczeza* were performed in 5 samples in the Lower Ordovician (*M. polonica*) and in 27 samples in the Middle Ordovician (*M. jaanussoni* and *M. sanctacrucensis*). Altogether 300 specimens in various moult stages were measured (Text-fig. 8). Between adult specimens of *M. polonica* (average length 1.4 mm) from the *A. variabilis* Zone and adult specimens of *M. jaanussoni* (average length 1.8 mm) from the *Pygodus serra* Zone there is a specimen length increase of approximately 0.5 mm and an average height increase of approximately 0.3 mm. Specimens of *M. sanctacrucensis* from the *A. tvaerensis* Zone show further increase in shell size. Specimens of moult stage A-1 are larger than specimens of the same moult stage in an earlier population. Among the *M. sanctacrucensis*, unfortunately no female specimens were found, which would have allowed precise determination of adult size of this species. An increase in shell size was observed in all moult stages of sequentially appearing populations.

(6) *Ampletochilina prisicina* sp. n. – *Swantina schallreuteri* sp. n. lineage. 102 specimens of *S. schallreuteri* from 17 samples from the *P. serra* Zone to the *A. superb* Zone were measured (Text-fig. 9). Adult specimens of this species appear in samples in the entire just mentioned part of the section.
Fig. 7.

Size dispersion of *Uhakiella diuturna* sp. n. Samples MA-43, 45, 46, 47, 48 – lower part of the *Pygodus serra* Zone; samples MA-50, 54, 58, 59 – upper part of the *Pygodus serra* and lower part of the *Pygodus anserinus* Zone; samples MA-84, 85, 86, 89 – middle and upper part of the *Amorphognathus tvaerensis* Zone.

Between adult specimens of *S. schallreuteri* of the lower part of the *P. serra* Zone (average length 1.1 mm) and the lower part of the *A. superbus* Zone there is a length increase of about 0.4 mm, and an average height increase of about 0.15 mm. Here, one can also perceive a small increase in the average size of the youngest documented moult stages of approximately 0.05 mm. Even smaller (Text-fig. 9) than specimens of *S. schallreuteri* of the lower part of the *P. serra* Zone, are specimens of a closely related species *Ampletochilina priscina* sp. n. from the lower part of the section (*A. variabilis* Zone). The length of its heteromorphic valves does not exceed 1.1 mm there.

(7) *Klimphores* lineage. Three species of *Klimphores*, which occur in temporal sequence and display a number of characteristics suggesting their close relationship, were also studied. They also show a similar tendency to increase shell size with time (Text-fig. 10). Between the Early Ordovician *K. (L.) ansiensis*, *K. (K.) subplanus* from *Pygodus serra* Zone and *K. (K.) vannieri* from the *A. superbus* Zone, the increase of adult shell average length of about 0.3 mm and the increase of the corresponding average height of 0.15 mm occur.

The tendency to increase shell size characterizes species of highly variable adult size e.g. *Majczella jaanussoni* – heteromorph shell length from the *P. serra* Zone is about 2 mm, *Lembitsarvella polonica* – suspected heteromorph shell length 5–6 mm, *Piretia tenuistriata* – shell length of 1.5–2 mm, *Swantina schallreuteri* – 1.0–1.5 mm, adult specimens of *Klimphores (K.) subplanus* – 0.7–0.8 mm, *Gryphiswaldensis cavata* – 0.7–1.0 mm. This suggests a general tendency, and not a result of secondary changes in population composition such as transport and selection of shells of particular size although a destruction of specimens of shell size above 2–3 mm is a common feature.

A similar tendency shown by a number of taxa occurring over a long time span suggests environmental control. It was possibly phenotypic but fossil material is inconclusive in this regard. REYMENT (1966, 1978) observed that many Cretaceous-Paleocene species from Africa have synchronous size fluctuations through time and believed this to indicate environmental control [see MADDOCKS (1977); BARKER (1963); ISHIZAKI (1975); KAESLER (1975); KEEN (1982); REYMENT (1982, 1988); REYMENT et al. (1977) for similar studies]. PEYPOUQUET’S (1977) and RZIHA (1989) studies of the Recent species of the genera *Krithe* and *Parakrithe* indicate that the composition of the dissolved nutrients determines
Fig. 8.
Size dispersion of Mojczella lineage. Mojczella polonica: samples MA-117, 118, 120 – Amorphognathus variabilis Zone. Mojczella jaanussoni: samples MA-45, 46, 47, 49, 52 – middle part of the Pygodus serra Zone; samples MA-54, 55, 56 – upper part of the Pygodus serra Zone; samples MA-58, 59 – boundary of the Pygodus serra/Pygodus anserinus Zone. Mojczella sanctacrucensis: samples MA-84, 85 – middle part of the Amorphognathus tvaerensis Zone.
the size of the ostracod shells. Other authors (Pokorny 1980; Steineck et al. 1984) believe that temperature is a determining factor. This type of study of shell size variation on Palaeozoic ostracods are very limited particularly because of the absence of appropriate material. Mójcza Ordovician sequence is of particular importance because of the relatively long period of time represented in the sequence, lack of significant changes in the character of the sediment and presence of long-ranging species, and the availability of substantial numbers of specimens in each population.
VARIATION IN ORNAMENTATION

The special mode of preservation of the Mőjcza ostracods allows the extraction of large quantities of specimens representing different moult stages from samples. This together with the generally long
Evolution of the genus *Mojczella* at individual moulting stages; A/L ratios of distance between C1 and C3 (measured beneath the sulcus) and length of valve, horizontal bars show range of variability in particular samples, mean values are connected by vertical lines (modified after OLEMPSKA 1989).

Durations of several species in the section enables observations which would not have been possible with material preserved as calcareous shells that are hard to extract from the rock, occur in low numbers of specimens, and only rarely allow observations on small morphological details. Changes in macro- (ridges, spines etc.) and microornamentation (granulation, reticulation, punctuation) in both ontogeny and phylogeny have been studied in several representatives of Palaeocopa and Binodicopa. The inner surface of phosphate linings of the shell represents precise surface replicas, which allow for the recognition of extremely fine details of ornamentation. This type of preservation guarantees that the observed microornamentation has not been significantly changed during diagenetic processes, because the phosphate coating of the shells probably took place before the covering with sediment, and the diagenesis.

Clear differences in the character of changes between the macroornamentation and microornamentation were observed. The larger structures in certain species (not in all) are subject to significant
changes both in ontogeny and in the subsequently appearing populations of the species. Fine ornamentation appears to be far more conservative in the ostracods studied. Closely related species (Mojczella lineage, Klimphores lineage), are characterized by virtually identical shell microornamentation.

**Evolution of macroornamentation.** — In some species the massive crests present on the shell surface change their shape, length and thickness both in ontogeny and phylogeny. In species of the genus Mojczella which appear sequentially over time, a tendency for strengthening of the carapace by gradual lengthening of the sulcus-surrounding crest was observed. For the detailed biometric studies of this chronomorphocline see Olempska (1989). All characters in which the oldest and youngest populations of the Mojczella lineage differ from each other show continuous transformations in the Mójcza section (Text-fig. 11). The changes in character, which can easily be studied biometrically, i.e. the quantitative features of the sulcus-surrounding crest, are virtually linear in geologic time. As the relative thickness of the conodont zones suggests that the rate of sedimentation in the section at Mójcza was more or less uniform (Dzik 1990), the rate of evolution was probably almost constant. This concerns the evolution of all moults. However, the rate of evolution of the sulcus-surrounding crest was found not to be uniform in individual moult stages. It is highest in adult individuals. At late moult stages (A-1, and A-2), it is slightly lower, but not as low as in the earliest moult stages (A-5 and A-6), where the transformations of morphological features appear quite difficult to trace. This means that in the course of the evolution new morphological features appear at successively younger and younger moult stages (Olempska 1989).

In populations of Mojczella from the Early Ordovician (A. variabilis Zone) the mode of development of the crest at early stages is similar to that in late moult stages as well as in adult specimens. In populations of Mojczella from higher parts of the section the differences in morphology increase in successive instars, being greatest in populations of Mojczella from the A. tværensis Zone. In these populations specimens of the early moult stages (A-5) basically differ from those of late stages (A-1, A-2) and the adults (A). The identification of particular stages in the evolution of Mojczella and, therefore, of the chronospecies, is possible only on the basis of adults or specimens representing the latest moult stages (A-1, A-2).

**Microornamentation.** — Ordovician ostracods display three different types of microornamentation known as granulation, reticulation, and punctuation as well as combinations of those three types. Microornamentation preserved in the natural replicas allows for recognition of details that are not visible on the external surface of the phosphatic linings covering the shells. Moreover, among species with very similar microornamentation of the surface linings, the negative images reveal the differences better. Even with this new tool for studying the microornamentation, minimal or no change of this morphologic character through time was found. In three successive species of Mojczella where evolutionary changes of the more massive morphologic elements took place, the form of polygonal microscopic ornamentation did not undergo any changes, beginning with the population of Mojczella polonica (Pl. 39: 1–3) from the A. variabilis Zone, through M. jaanussoni (Pl. 40: 1–2) from the P. serra — P. anserinus Zones, to M. sanctacrucensis (Pl. 40: 3–4) found in the upper part of the A. tværensis and lower part of the A. superbus Zone. The microornamentation of the Lembitsarvella polonica was identified in various populations beginning from the P. serra Zone, P. anserinus Zone (Pl. 32: 2–3, 5, 6), A. tværensis Zone (Pl. 32: 4), and ending in the population found in the sediments of the A. superbus Zone. The shell surface of this species is composed of two layers (Text-fig. 12, see also p. 156). The inner layer microornamentation is characterized by small tubular protuberances connected by a network of delicate nuri, observed on the phosphate linings surface and their replica. This remains unchanged over the entire period of this species existence in the section. Lembitsarvella sp. from Lower Ordovician sediments is characterized by a similar shell surface microornamentation (Pl. 28: 4). Changes in the microornamentation character of the Piretella oepiki were traced in the section from the P. serra Zone to the A. superbus Zone (Pl. 27: 1–4). The shell surface of this is ornamented by small granules of polygonal arrangement separated by rather deep lumina. No significant changes in microornamentation through time were observed here, however, this species is present in small quantities and precise study was impossible. In the two above mentioned species, no significant macroornamentation changes were observed either. Microornamentation did not change in
Uhakiella diuturna as well. Studies were conducted on populations beginning with the P. serra Zone and ending with the A. superbus Zone.

In those species which were represented by a relatively large number of specimens of younger moult stages, the character of microornamentation changes during ontogeny was also studied. This concerns species of Mojczella (M. jaanussoni and M. sanctacrucensis), Lembitsarvella polonica, Piretella oepiki, and Gryphiswaldensia cavata. In all these species the basic appearance of microornamentation was already developed in the youngest moult stages available for study. Only in the youngest moult stages of Lembitsarvella polonica a slightly different microornamentation can be recognized in the marginal zones of shells (Pl. 39: 4). In the remaining moults, including adult specimens, the microornamentation remains without change. According to Martinsson (1962) microornamentation structures may seem very different but they might be very similar in origin. This type of microornamentation was described by Liebau (1977) as “proto-level” ornamentation. According to Liebau (1977), genetic changes may affect the whole ornament component or inexacty defined parts of it, but not single elements, therefore, single elements (meshes, pore cones, etc) do not possess individual character of e.g. intraspecific constancy, and cannot be used individually for taxonomic purposes. Proto-ornamentation represents, according to Liebau (1977), the primitive stage of ornamentation. The studies of Ordovician ostracod microornamentation from Mojczra fully confirm this view. Peypouquet (1977) maintains that the principal parameter for many ornamental changes is the ionic concentration of calcium and magnesium and clear correlation is found between strong ornamentation and high Ca$$^{++} + \text{Mg}^{++}$$ concentration. Microornamentation is much less dependant on changes in water chemistry than is macroornamentation.

OSTRACOD SHELL STRUCTURES

The state of preservation of ostracods as thin phosphate layers coating the primary internal and external surface of the shells, with an empty space left behind by the calcite shell dissolved in acetic acid, allowed for the observation of a number of characteristics of internal shell construction, thus far little known in Paleozoic ostracods. In this space, phosphate fillings of some originally empty cavities within the shell are preserved (Text-fig. 12a). These include fillings of pore canals and tubules in the velar structures, accessible to observation by electron microscopy. In the normal state of preservation of shells, this type of detail of the internal structure of the shell are only accessible for fragmentary observation in thin sections.

PORE CANALS

The calcified outer lamella in ostracods is penetrated by pores which carry bristles. These pores are more or less evenly distributed over the shell, being more numerous only at the margins. In post Paleozoic and Recent ostracods pore canal exits on the shell surface are usually quite visible. They can be also studied in transmitted light inside the shell. Pore canals of Paleozoic ostracods are poorly known chiefly because of significant diagenetic changes which obscure fine details on the shell surface.

In several ostracod species of Mojczra, the presence of well preserved phosphate fillings of pore canals was identified. On the phosphate coatings’ surface, even with high magnification, the pore canal are not visible because of infilling and covering of their exits (Text-fig. 12a). Pore canal fillings can be seen in damaged specimens as very thin filled tubes connecting the phosphate layers which coat the inner and outer surface of shells. The regular placement pattern of these structures in the shell, the relatively stable number observed in various species, and their perpendicular course between the walls, distinguish them from canal fillings left by drilling organisms which can be found in some specimens (Olempska 1986).
The best preserved pore canal fillings were found in those samples in which ostracode shells are coated with a relatively thicker layer of calcium phosphate. The most numerous specimens with preserved pore canal fillings were found in sample MA-99 from the Amorphognathus superbus Zone (Caradoc).

**Normal pore canals.** — Normal pore canals are ducts which penetrate the carapace to terminate at right angles to the surface. They may form junctions either as tegumental ducts, connected in life to tegumental glands beneath the epidermis, or as ducts housing individual sensory setae (Sylvester-Bradley and Benson 1971).

Among the Mójcza ostracods, in many specimens of Trianguloschmiditella (Rempesgrinella) hemiventricostata from the A. superbus Zone, normal pore canal fillings were found ("sensillum pore" of Okada 1983). They appear as fillings of simple (non-branched) canals with a diameter of about 0.01 mm, coursing in a perpendicular fashion between the outer and inner phosphate layer (Pl. 50: 1–2). They are distributed quite regularly inside the shell. They number about 30 inside each valve. In this species, pore canal concentrations in particular regions of the shell were not found. Pores are equally distributed over the right and left valves. When the phosphatic coats are damaged, fillings of pore canals usually suffer destruction, except T. (R.) hemiventricostata in which they are exceptionally well preserved. The presence of normal pore canals, preserved as small spines or larger canal fragments on the coats covering the inner wall of the shell, was also observed in several other species such as Colliboibina postaculeata and Swantina schallreuteri. Spines on the surfaces of the steinkerns proved the existence of pores in the shell. Specimens of Lembitsarvella polonica and Bromidella sp. demonstrated the presence of unusually concentrated pore canal fillings along the ventrolateral surface (Pl. 50: 3, 4). The appearance of concentrations of setae along the ventrolateral surface, as documented by Swenson (1989) in Recent genus Manawa, indicate that these regions are important sources of "sensory" information relating to the external environment and possibly, mating position during copulation.

**Pore clusters.** — Some Mesozoic and Recent ostracoda (Eucytherurinae, Punciidae) possess clusters of pores occupying each solum of the exterior reticulate ornament, which penetrate to the interior of the carapace, producing a pattern of clustered perforations corresponding directly to the exterior reticulate ornament without accompanying setae (Müller 1894; Ishizaki 1973; Ishizaki and Gunter 1974; Maddocks and Steineck 1987; McKenzie and Neil 1983; Steineck et al. 1990). The function
of such “sieve pores”, not associated with setae is not clear. Pore clusters in Ordovician ostracods were illustrated by Schallreuter (1977a) in Miehlkella criboporata. They consist of rings of pores, one ring of 5 to 8 micro-pores. Later Schallreuter (1980a, 1983d) illustrated also pore clusters in Klimphores planus and Vaivanovia hiddenseensis. Schallreuter (1983d) supported the suggestion of Müller (1894) that pore clusters had a light sensory function.

Among the ostracods from Mójca Limestone, clusters were found in Klimphores (K.) vannieri from the A. superbus Zone. They are preserved as phosphatic fillings visible after damaging a specimen. At the base of every sola in the reticulum, 7–10 canals are found, with a diameter of 2–3 μm each (Pl. 51: 1–3). All canals are of the same diameter, there is no unequivocal proof that one of them, as in true sieve-pores, was a canal through which the sensory bristle travelled. Klimphores (K.) vannieri possesses only pore clusters on its valves. In Klimphores (K.) subplanus poorly preserved fillings of pore clusters are also present. Pore clusters in K. (K.) planus Schallreuter and K. (K.) vannieri sp. n. differ only by a significantly higher number of micro-pores, around 30 per solum in K. (K.) planus.

Pore clusters described by Jones (1988) in Amphissites and pore clusters illustrated by Coen, Michelis, and Parisse (1988) in a Carboniferous Kirkbyacea genus, possess similar construction. According to Swenson (1989) the term “sieve plate” in Klimphores was an unfortunate choice since we now understand the sieve plate as the calcified portion of the multiple pouch structure of each sensillum (Okada 1982, 1983). “Sieve plate” implies that the structure is associated with, or is part of a normal pore, although no evidence exists to suggest setae protruded from such a structure on the valves of these Palaeozoic ostracods (Swenson 1989).

**SHELL STRUCTURE IN LEMBITSARVELLA**

In Lembitsarvella polonica an unusual type of shell structure was recognized, one unknown in other Ordovician ostracods. Certain fragments of the ornamental surface are composed of two layers connected by protuberances (Text-fig. 12b). Next to the domicilum the inner layer is ornamented with small tubular protuberances, each of about 0.02–0.03 mm in diameter, connected by a network of delicate muri (Pl. 32: 2). One cannot unequivocally state whether the primary protuberances possessed pore openings on their tops. Most of the protuberances are incompletely preserved in that they lack tops and reveal hollow centers (Pl. 32: 1, 6). The tops of complete protuberances are imperforate (Pl. 32: 2), which may be a result of coating by a phosphate layer. Tubular protuberances are uniformly distributed over the surface of shells with the exception of the crests surrounding the sulcus, dorsal crests, and velum.

On adult shells as well as late moult stages fragments of a second outer layer occur completely covering the above described layer (Text-fig. 12b). The outer layer is composed of large granules with a diameter of 0.04–0.07 mm, rather tightly packed (Pl. 31: 1–2). The granules do not show traces of any terminal openings. Moulds of dissolved tubular protuberances are visible on the inner walls of the damaged granules (Pl. 31: 3), or inside the granules. One cannot unequivocally state whether the outer layer of the granules originally covered the entire shell surface and after the animal’s death was partially worn off, or they were formed only on certain parts of the shells. It was observed with subsequent molts that a greater and greater part of the shell surface was covered by a granular layer. The state of preservation and the visibility of details of ornamentation of the inner layer depend also on the thickness of the phosphate layer coating the primary surface. The thicker it is, the more obscured and less visible are the details.

A two-layered shell, very similar in its construction, was described by Kesling (1954), Adamczak (1968), and Kesling and Chilman (1987) in the Devonian genus Ctenobolbina. In this genus the ornamented area of the lobes consists of two layers. The thicker inner layer is separated from the very thin and delicate outer layer by pillars. Kesling (1954) suggested that the presence of the outer layer was caused by a replacement of the original chitin layer with calcium carbonate, which had been destroyed soon after the organism’s death. Kesling and Chilman (1987) proposed, that the spaces between pillars were originally filled with fluid or gas. In either case they made the carapace lighter in weight and the gas-filled spaces may have been significant in buoyancy.
OSTRACODS OF THE MÓJCZA LIMESTONE

The structure of tubular protuberances in *Lembitsarvella* shows a certain similarity to similar fine surface structures in the Silurian paleocope *Neobeyrichia lauensis* (Kiesow, 1888) illustrated and discussed by Siveter (1982). Tubular protuberances in this species, each of about 8–12 μm in diameter, densely cover the lateral surface of lobes. They reveal hollow centres, that may have a buoyancy function or were perhaps produced to make the shell lighter and thinner for economy of the carapace design. It is also possible that they acted as part of a typical mechanoreceptor or chemoreceptor system (Siveter 1982). Many similar structures in Recent ostracods represent a very thin organic layer coating the shell, which after death is destroyed very quickly.

The two layer wall structure in *Lembitsarvella* suggests its buoyancy function. Its connection with the original chitin layer appears improbable. The coating of ostracod shells with phosphate did not occur in such a short time after the death of the animal as to allow the chitin layer to remain preserved. There is also a possibility that the presence of the outer granular layer is a result of more complex processes of coating of the ostracod shells with phosphate, that is, the secondary phosphatic layer does not represent the original ornamentation. The absence of structures of this type among other species coexisting with *Lembitsarvella* makes this interpretation unlikely.

In *Lembitsarvella polonica* the presence of additional structures such as separate chambers was noted. They are present inside crests surrounding the sulcus and inside dorsal crests (Pl. 30: 1, 2). It seems very likely that these structures, like those described above and the tubules inside the velar structure, had a similar hydrostatic function and also lowered the ostracode shell weight.

**MORPHOLOGY OF THE TUBULOUS VELUM IN LEMBITSARVELLA**

Although the tubulous velum is the main classificatory feature of the entire superfamily Eurychilinacea and it occurs in many Ordovician genera, its internal construction, development in ontogeny and its function are not fully understood.

The species *Lembitsarvella polonica*, from the Middle Ordovician of Mójcza, is characterized by the presence of a broad velum with large, wide tubules and well developed edge structures (Text-fig. 13). Tubular calcium phosphate fillings allow one to study their structure (Pl. 28: 4; Pl. 29: 2, 8; Pl. 30: 6–8), and to trace its development in the ontogeny (Pl. 29: 1–5). In most of the *Lembitsarvella polonica* specimens, the tubules are completely isolated from the domicilium, but specimens with tubules open to the domicilium, especially late moult stages and male and female adults were also found (Pl. 30: 3–5). Origin and function of the cruminata and tubulous velum of beyrichid ostracods
were studied by Martinsson (1960, 1962) and Adamczak (1990). According to Martinsson (1962), the tubules were formed in an initial stage of calcification of the carapace by a morphological or physiological differentiation of the epithelium. With the exception of one specimen, Martinsson (1962) never observed communication of the tubules with the domicilium of the carapace; according to Martinsson (1962), open tubules could remain only when the completion of the last molting had been interrupted in an early stage. Scott and Winwright (1961) published schematic cross sections through some Palaeocopas which have tubules or velar folds opening towards the domicilium. According to Martinsson (1962), perhaps more primitive Palaeocopas had an open velar fold, or even tubules, but such hardly existed in normally developed Amphitoxotidae.

While studying thin sections of specimens of Craspedobolbina (Mitroberychia) clavata (Kolmodin, 1869) from the Silurian of Gotland, Adamczak (1990) observed in the crumina the presence of two cavities: a large intravelar space (infated tubules) and dolonoid pouch (antrum). According to Adamczak (1990) these cavities functioned as a buoyancy organ. The intravelar space, in this hydrostatic structure, acted as a gas tank, whereas the dolonoid pouch worked as a ballast tank and/or brood pouch if it was filled with eggs and/or young instars (Adamczak 1990). It is possible that all tubules of Ordovician ostracods which possessed a tubulous velum functioned as a hydrostatic organ, as gas reservoirs. They were separated from the domicilium by only a thin weakly calcified membrane. The presence of relatively frequent specimens of L. polonica with tubules open to the domicilium, especially in adult specimens, supports this hypothesis. The relatively thin wall separating the tubules from the domicilium could have been easily damaged.

The velum in Lembitasarvella polonica has well developed edge structures very similar to the velar structures of Silurian Beyrichidae and unknown until now among Ordovician ostracods with a tubulous velum. Along the outer side of the velum there is a thin crest (border crest in Silurian ostracods, Martinsson 1962) and narrow torus along the inner side of the velum. These structures play an important role in the formation of the dolon in hetermorphs of Lembitasarvella. In preadult female moult stages a significant thickening of the border crest, velar edge and torus occurs (Pl. 29: 9). The dolon is formed as an effect of the enlargement of the space between these structures. Along the edge and below the torus an additional wall is formed (Pl. 29: 6, 7). This kind of origin for the heteromorphic velum was until now unknown among Ordovician Eurychilinacea. Among the majority of Eurychilinacea the dolon is formed by a lengthening and bending of tubules in the direction of the ventral margin. The tubules in the velum of the females of L. polonica are subject to a significant widening at the ends, they do not reach the dolon edge (Pl. 30: 9).

The appearance of the tubulous velum in the process of ontogeny in Lembitasarvella polonica takes a different course from that of Silurian Craspedobolbina clavata, where the ontogeny was traced with detail by Martinsson (1962). Unlike C. clavata, whose velar frill is already well formed at the eighth moult stage (A-8), and in A-7, the velum is developed as a flange, in L. polonica in the four youngest defined moult stages, the velum is developed as thorny outgrowths, widening into wide tubules covered by the outer wall only in the two or three last moult stages. The velar structure ontogeny in other Ordovician Eurychilinacea has not been studied thus far.

**SHELL STRUCTURE IN PINNATULITES PROCERA**

While studying shells of Pinnatulites procera in thin sections, Hessland (1949) identified “openings” traversing the entire thickness of the shells. Many specimens of P. procera present in the Mójcza’s Early Ordovician, allowed for significantly more accurate observation of these structures. It was found that all openings shaped as long triangles, which are present on the outer surface of shells (Pl. 47: 4), pass through the shell to its inside and open on the interior surface of the shell as large round openings (Pl. 47: 5), with a diameter of about 0.04–0.07 mm (Text-fig. 14). Such a porous construction of large shells of P. procera, with an adult shell length of approximately 4–5 mm, may have diminished their weight, giving them some opportunity for more active swimming which could have explained the wide geographic distribution of this species. It is also possible that they functioned as normal pore canals, the “sensium pores” of Okada (1983), or had a light-sensory function. The shell structure of Pinnatulites seems to be similar to the tubular structure in Tubulibairdia valves and
other Silurian and Devonian pachydomellids. But unlike to *Pinnatulites*, tubules in *Tubulibairdia* valves open only on the interior surface of the shell. According to LUNDIN (1988), tubules in *Tubulibairdia* and other pachydomellids had a sensory function (sensing of light) or a function in formation of the cuticule of the ostracode.

**TAXONOMIC DESCRIPTIONS**

**TERMINOLOGY**

The terminology of the morphology of Ordovician ostracods remains comparatively stable (KESLING 1951, JAANUSSON 1957, MARTINSSON 1962, HENNINGSMOEN 1965; SCHALLREUTER 1973; VANNIER 1986a–b). The currently used terminology was summarized by VANNIER et al. (1989: Text-figs 6–9), and this terminology is followed here. The terminology of shell structure and microornamentation is discussed separately above. VANNIER et al. (1989) and BERDAN (1988) classification has been applied in the present paper.

All measurements are in millimetres unless stated otherwise. Only complete valves were measured.

The terms heteromorph and female are synonymous; both are used in the text; tecnomorph refers to the male and larval forms.

Subclass **Ostracoda** Latreille, 1802 (*nom. correct.* Latreille, 1806)
Order **Beyrichiocopida** Pokorný, 1953 (*emend.* Schallreuter, 1980)
Suborder **Palaeocopa** Henningssmoen, 1953 (*nom. correct.* Jaanusson, 1957)
Superfamily **Eurychilinae** Ulbrich et Bassler, 1923 (*nom. transl.* Jaanusson, 1957)
Family **Oepikellidae** Jaanusson, 1957 (*emend.* Hessler in Benson et al., 1961)
Subfamily **Ampletochilinae** Schallreuter, 1975

Genus **Ampletochilina** Schallreuter, 1969

**Ampletochilina priscina** sp. n.
(Pl. 33: 1–3; Text-fig. 9)

**Holotype:** ZPAL O.XXV/418.

**Type horizon:** *Amorphognathus variabilis* Zone, Early Ordovician.

**Type locality:** Mójczka, Holy Cross Mountains, Poland.

**Derivation of the name:** From Latin *priscus* – ancient, old.

**Diagnosis.** — Length of heteromorphs 1.1–1.2 mm. Outline slightly preplete. Cardinal angles more than 90°. Dolon slightly convex, broadest in anteroventral part.

**Material.** — 11 tecnomorphic and 2 female valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 9):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/418</td>
<td>broken</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/504</td>
<td>0.92</td>
<td>0.50</td>
</tr>
<tr>
<td>ZPAL O.XXV/505</td>
<td>broken</td>
<td>0.63</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline slightly preplete. Indistinct sulcal depression. Tecnomorphic velum not reaching anterior cardinal corner, moderately wide in anteroventral part, narrow in ventral region, ending abruptly in posteroventral region. Dolon slightly convex, broadest in anteroventral part with tubules weakly visible externally. Marginal sculpture is narrow ridge that runs parallel with contact margin. Lateral surface of domicilium is covered by small rare tubercles.

**Remarks.** — This species is closely related to the stratigraphically younger *Swantina schallreuteri* sp. n., but differs in having an open antrum in the posteroventral part. *A. priscina* sp. n. is also similar to *A. ryghoofensis* Schallreuter, 1987, from Middle Ordovician erratic boulders, but differs in having a weaker sulcal depression.

**Distribution.** — In Mójczka it occurs only below the discontinuity surface in the *Amorphognathus variabilis* Zone, Early Ordovician.

Genus **Swantina** Schallreuter, 1986

**Type species:** *Ampletochilina swantia* Schallreuter, 1969.

**Swantina schallreuteri** sp. n.
(Pl. 33: 4–8; Text-fig. 9)

**Holotype:** ZPAL O.XXV/62.

**Type horizon:** *Pygodus serrae* Zone, Middle Ordovician.

**Type locality:** Mójczka, Holy Cross Mountains, Poland.

**Derivation of the name:** In honour of Dr. Roger Schallreuter from Hamburg.

**Diagnosis.** — Length of heteromorphs 1.02–1.50 mm. Valve outline slightly preplete. Indistinct sulcal depression. Dolon in anteroventral and ventral parts with keel parallel and close to the margin. Ornamentation consist of small tubercles.

**Material.** — 120 tecnomorphic and 24 female valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 9):
OSTRACODS OF THE MÓJCZA LIMESTONE

Description. — Valve outline slightly preplete. Almost non-sulcate, with indistinct slightly curved sulcal depression. Valves moderately convex, highest convexity slightly behind sulcal depression. Velum in tecnomorphs medium-wide, not reaching anterior cardinal corner, posteriorly becoming rather abruptly obsolete before reaching posterior region of valve. In anteroventral and ventral region of heteromorphs, velum forms convex dolon, widest anteriorly. Antrum is closed by narrow ridge slightly behind middle of ventral margin and then velar structure continues as moderately wide ridge; it reaches posteroventral region of valve. Distinct keel runs parallel and close to margin of dolon; it is visible only in well preserved specimens. Tubules are weakly visible externally. Marginal sculpture is narrow ridge that runs parallel with contact margin. Ornamentation of domicilium consists of small tubercles. Surface of dolon is smooth.

Remarks. — S. schallreuteri sp. n. resembles S. swantia from Middle Ordovician (late Viruan) erratic boulders (SCHALLREUTER 1969) but differs in the narrower velar structure in tecnomorphs, presence of the keel on the dolon margin and the indistinct sulcal depression. The valve outline, weak sulcal depression and ornamentation of the surface of S. schallreuteri sp. n. and Ampletochilina ryghoofensis from late Viruan erratic boulders (SCHALLREUTER 1987) are very similar; S. schallreuteri differs in having a closed antrum. According to SCHALLREUTER (1986) a closed antrum is the main diagnostic feature of Swantina. S. schallreuteri sp. n. is most closely related to Ampletochilina priscina sp. n. from the Early Ordovician of the Mójcza Limestone. S. schallreuteri presumably evolved from an A. priscina — like ancestor.

Distribution. — In Mójcza it occurs from the discontinuity surface (Pygodus serra Zone) and is quite common up to 2.4 m above the bentonite (Amorphognathus superbis Zone), Middle and Late Ordovician.

Genus Platybolbina HENNINGSMOEN, 1953
Subgenus Platybolbina (Reticulobolbina) SCHALLREUTER, 1969

Type species: Platybolbina (Reticulobolbina) integra SCHALLREUTER, 1969.

Platybolbina (Reticulobolbina)? sp.
(Pl. 25: 9)

Material. — One external mould.

Dimensions:

<table>
<thead>
<tr>
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<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/7</td>
<td>1.87</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Remarks. — One specimen of Platybolbina has been found in the present material. Unfortunately the material is too badly preserved to be described in detail, although it is sufficient to allow the following remarks to be made: the valve outline is preplete, dorsal margin long and straight, velar frill narrow, and a drop-shaped muscle scar is present. The lateral surface is distinctly reticulate. This Platybolbina (R.) species resembles P. (R.) kapteyni (BONNEMA) from the Middle Ordovician of Sweden (THORSLUND 1940; JAANUSSON 1957, 1960, 1963), Estonia (SARV 1959), and erratic boulders (SCHALLREUTER 1975a).

Distribution. — In Mójcza it occurs only in the Amorphognathus superbis Zone, Late Ordovician.

Family Eurychilinidae ULRICH et BASSLER, 1923 (nom. transl. HENNINGSMOEN, 1953)
Subfamily Piretellinae ÖPIK, 1937 (nom. transl. KAY, 1940)

Genus Hesperidella ÖPIK, 1937

Type species: Primitia esthonica BONNEMA, 1909.
Hesperidella posterospinata sp. n.
(Pl. 25: 10–12; Text-fig. 15)

Holotype: ZPAL O.XXV/166.
Type horizon: Pygodus anserinus Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.

Derivation of the name: From Latin post – posterior and spina – spine, referring to the posterodorsal and posteroventral spines.

**Diagnosis.** — *Hesperidella* with large preadductorional knob, distinct posterior crest and lacking dorsal plica. Velar frill wide, terminating in posteroventral region with long spine. In posterodorsal part of the valves long spine is also present.

**Material.** — 9 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/81</td>
<td>0.48</td>
<td>0.32</td>
</tr>
<tr>
<td>ZPAL O.XXV/166</td>
<td>0.54</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/482</td>
<td>1.01</td>
<td>0.61</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline approximately amplete. Dorsal margin straight. Anterior margin rounded; ventral margin gently curved. Preadductorional knob large (PAN), just reaching dorsal margin. Adductorional sulcus moderately wide, slightly curved anteroventrally, extends to half height of domicilium. Slightly curved crest (C3) surrounds sulcus in posterior part of valve. Shallow depression is developed in front of preadductorional knob. Dorsal plica is absent. Long spine is present in posterodorsal region of valve, usually broken. Small spine developed in anterior part of dorsal margin. Velum in tecnomorphs wide, especially ventrally, slightly restricted anteroventrally, gradually narrows towards anterior cardinal corner. Anteriorly velum reaches dorsal margin near anterior cardinal corner, it may protrude above dorsal margin. Posteroventrally velar frill is abruptly constricted with a long spine (Text-fig. 15). Velar tubules wide, well developed. Marginal sculpture consists of row of small tubercles near contact margin of each valve. Sulcus and velum smooth, domicilium reticulo-granulate with relatively large tubercles of somewhat varying size. Heteromorphs are absent.

**Remarks.** — *Hesperidella posterospinata* sp. n. resembles *H. esthonica* (BONNEMA) from the Middle Ordovician of Baltoscandia (SARV 1959; JAANUSSON 1957; SCHALLREUTER 1975a), but differs in lacking the anterior and posterior arch of the dorsal plica and presence of a long spine at the end of the velar frill and in the posterodorsal region. *H. posterospinata* sp. n. differs from *H. michiganensis* from the Middle Ordovician of Michigan (KESLING, HALL and MELIK 1962) in lacking the dorsal plica. *H. posterospinata* sp. n. seems to be similar to *Gellensia gotlandica* SCHALLREUTER, from the Late Ordovician erratic boulders (SCHALLREUTER 1967a) in having posterodorsal and posteroventral spines.

**Distribution.** — Rare specimens have been found in the Pygodus serra and Pygodus anserinus Zones, Middle Ordovician.

**Genus Piretella ÖPIK, 1937**

Type species: *Piretella acmaea* ÖPIK, 1937.

**Piretella oepiki** THORSLUND, 1940
(Pl. 26: 4–7, Pl. 27: 1–4)

1940. *Piretella oepiki* sp. n.: THORSLUND, p. 175, Pl. 4: 1–5.
Material. — 8 tecnomorphic valves and 1 female valve.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/96</td>
<td>1.52</td>
<td>1.01</td>
</tr>
<tr>
<td>ZPAL O.XXV/164</td>
<td>1.28</td>
<td>0.92</td>
</tr>
<tr>
<td>ZPAL O.XXV/248</td>
<td>1.19</td>
<td>0.88</td>
</tr>
<tr>
<td>ZPAL O.XXV/449</td>
<td>0.72</td>
<td>0.54</td>
</tr>
</tbody>
</table>


Remarks. — The specimens described differ from the holotype in a longer dolon in heteromorphic specimens.

Distribution. — Sweden: Upper Chasmops beds of Central Lockne area, Jämtland. In Mójcza it occurs from the upper part of the Pygodus serra Zone up to the Amorphognathus superbus Zone, Middle and Late Ordovician.

Piretella amphiocrisita sp. n.
(Pl. 26: 10–11)

Holotype: ZPAL O.XXV/86.
Type horizon: Pygodus serra Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Greek amphi – at both sides, and Latin crista – crest.

Diagnosis. — A species of Piretella having two discrete crests; one in front of preadductorital node, second behind adductorital sulcus; they reach dorsal margin. Velar frill wide, in posterior region replaced by 6–8 long spines.

Material. — 4 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/86</td>
<td>0.80</td>
<td>0.48</td>
</tr>
<tr>
<td>ZPAL O.XXV/526</td>
<td>0.66</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Description. — Valve outline subamplete. Preadductorital node small, rounded. Adductorital sulcus weakly developed. Two almost straight crests extend from dorsal margin to mid-height of valve. Dorsal plica is absent. Tecnomorphs with wide velar frill in anterior and ventral part; extending from anterior cardinal corner; in posterior part replaced by 6–8 long spines. Velar tubules long, narrow. Marginal sculpture is row of closely spaced tubercles. Surface of the domicilium reticulo-granulate. Females not found yet.

Remarks. — This species appears to be closely related to P. oepiki THORSLUND (see above). The latter possesses a U-shaped crest enclosing the adductorital sulcus and preadductorital node.

Distribution. — In Mójcza it is rare in the Pygodus serra and Amorphognathus tvaerensis Zones, Middle Ordovician.

Genus Lembitsarvelia gen. n.

Type species: Lembitsarvelia polonica sp. n.

Derivation of the name: In honour of Dr. Lembit SARV from Tallinn, Estonia.
Diagnosis. — Eurychilinidae having velar structure anteriorly and ventrally developed as wide tubulous frill; posteriorly it passes into velar ridge, extending to posterior cardinal corner. Heteromorphs with strongly convex dolon with four thick ridges parallel to margin. Sulcus and preadductorial node surrounded by a U-shaped crest. Dorsal plica well developed.

Remarks. — Lembitsarvella gen. n. shows a close resemblance to Piretella ÖPIK, 1937 in the ornamentation of crests and the outline of the valve and its size, but differs in having the tecnomorphic velar structure in posterior region as a ridge and heteromorphs with four thick ridges on the dolon. For morphology of the velum in Lembitsarvella see p. 157, and for ornamentation of the surface see p. 156.

Species included: Lembitsarvella polonica sp. n., Lembitsarvella sp.

**Lembitsarvella polonica** sp. n.

(PIs 28: 5–8; 29: 1–9; 30: 1–8; 31: 1–2; 32: 1–6; 39: 4; 50: 3–4; Text-figs 5, 12–13)

Holotype: ZPAL O.XXV/163.

Type horizon: Pygodus anserinus Zone, Middle Ordovician.

Type locality: Mójca, Holy Cross Mountains, Poland.

Derivation of the name: From Poland.

Diagnosis. — As for the genus.

Material. — 230 tecnomorphic valves, and 10 fragments of female valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 5):

<table>
<thead>
<tr>
<th>Valve</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/12</td>
<td>1.55</td>
<td>1.01</td>
</tr>
<tr>
<td>ZPAL O.XXV/35</td>
<td>1.60</td>
<td>1.01</td>
</tr>
<tr>
<td>ZPAL O.XXV/54</td>
<td>1.62</td>
<td>1.10</td>
</tr>
<tr>
<td>ZPAL O.XXV/163</td>
<td>1.69</td>
<td>1.10</td>
</tr>
<tr>
<td>ZPAL O.XXV/293</td>
<td>0.81</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/295</td>
<td>1.26</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.XXV/296</td>
<td>1.13</td>
<td>0.76</td>
</tr>
<tr>
<td>ZPAL O.XXV/430</td>
<td>1.21</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/433</td>
<td>1.23</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.XXV/438</td>
<td>1.21</td>
<td>0.75</td>
</tr>
<tr>
<td>ZPAL O.XXV/525</td>
<td>1.01</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Description. — Valve outline almost preplete. Maximum length of carapace at its mid-height. Domicilium uniformly convex. Anterior and posterior cardinal angles more than 90°. Preadductor node large, rounded. Adductor sulcus distinct, deep, parallel to posterior branch of crest. Crests U-shaped surrounding node and sulcus, continuing dorsally as dorsal plica. Anterior branch of crest evenly curved, continuous dorsally with dorsal plica; posterior branch of crest more or less straight, continues dorsally with posterior part of dorsal plica. Dorsal plica about as strong as crest; hindmost part rather long and posterovertrally curved. Dorsal plica protruding above the hinge-line. Tecnomorphic velum wide anteroventrally and ventrally, narrowing anteriorly, becoming ridge-like posteriorly. At end of ridge is small posterodor sal spine. Anteriorly it extends up to anterior cardinal corner. Border crest on outside of velum and near its edge. Toric ridge weak, occurs well below velar edge. Velar tubules wide. Fine concentric striation combined with tubulosity produces wrinkled pattern on upper and lower surface of velum (for morphology of velum of Lembitsarvella polonica see p. 157). Fragmented valves of heteromorphs have been found. The dolon has four thick ridges parallel to the margin. A line of small, tubercle-like processes occurs along each valve margin. Sulcus smooth. Domicilium reticulo-granulate (see p. 156).

Remarks. — The development of crests in L. polonica is similar to that in Piretella acmaea ÖPIK from the Late Ordovician of Estonia (ÖPIK 1937).

Distribution. — In Mójca, it occurs from Pygodus serra Zone up to the Amorphognathus tvaeren-sis Zone, Middle Ordovician.
Material. — About 25 tecnomorphic valves, almost all valves incomplete.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/292</td>
<td>1.19</td>
<td>0.76</td>
</tr>
<tr>
<td>ZPAL O.XXV/429</td>
<td>1.01</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Remarks. — The material agrees in most respects with the type species. However, as far as can be assessed, it is distinct from *L. polonica* in its smaller overall size, narrower velar frill and in having the velar frill in the posterior part of the valve. In *L. polonica*, along the posterior margin the velar structure is developed as a narrow ridge. More complete material is needed for determination of this species.

Distribution. — Common in *Amorphognathus variabilis* Zone, Early Ordovician.

Subfamily Chilobolbininae JAANUSSON, 1957
Genus *Laccochilina* HESSLAND, 1949
Subgenus *Laccochilina (Laccochilina)* HESSLAND, 1949

Type species: *Eurychilina estonula* ÖPIK, 1935.

Remarks. — In respect to the development of velar structure, two subgenera were distinguished within the genus *Laccochilina* by JAANUSSON (1957). In the subgenus *Laccochilina (Laccochilina)* the “velar structure is entire, reaching posteriorly up to the posterior cardinal corner without any considerable decrease in the width”, the subgenus *Laccochilina (Prochilina)* possesses the velar structure developed posteriorly as a row of spines (JAANUSSON 1957). Juvenile specimens of *L. (L.) berdaneae* sp. n. from Mőjczka, possess a velar frill extending to the end of the ventral region, in the posterior region replaced by spines; larger specimens have an entire velar structure. For this reason *Laccochilina* is in need of revision, but more material is needed to confirm this.

*Laccochilina (Laccochilina) berdaneae* sp. n.

(Pl. 26: 1–3)

Holotype: ZPAL O.XXV/471.
Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.
Type locality: Mőjczka, Holy Cross Mountains, Poland.
Derivation of the name: In honour of Dr. Jean BERDAN, Natural Museum of Natural History, Washington.

Diagnosis. — Adductorial pit narrow, preadductorial node small, oblong. Dorsal plica forming two arches. Lateral surface of domicilium ornamented by small number of rather small tubercles.

Material. — 38 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/129</td>
<td>0.58</td>
<td>0.38</td>
</tr>
<tr>
<td>ZPAL O.XXV/471</td>
<td>1.10</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/472</td>
<td>1.12</td>
<td>0.86</td>
</tr>
</tbody>
</table>


Remarks. — *L. (L.) berdaneae* sp. n. resembles *L. (L.)* sp. from the *Crassicauda* limestone, Sweden (JAANUSSON 1957) in the outline of valves, small preadductorial node and ornamentation of surface,
but differs in having a faint dorsal plica. There are also similarities to *L. (L.) dorsoplicata* HESSLAND, from the Early Ordovician of Sweden (HESSLAND 1949), but it differs in the shape of dorsal plica. 

**Distribution.** — In Mójca it occurs only below the discontinuity surface (*Amorphognathus variabilis* Zone), Early Ordovician.

**Family Oepikiidae** JAANUSON, 1957 (*emend. POKORNÝ, 1958*)

**Genus Duringia** SCHALLREUTER, 1984

Type species: *Eurychinina spinosa* KNÜPFER, 1968.

*Duringia*? aculeata sp. n.

(Pl. 25: 1–3)

Holotype: ZPAL O.XXV/66.

Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.

Type locality: Mójca, Holy Cross Mountains, Poland.

Derivation of the name: From Latin *aculeus* – spine, referring to spines on the valve surface.

**Diagnosis.** — *Duringia* with distinct preadductorial node. Tecnomorphic velum developed as row of spines. Dolon broad, strongly convex, tubulose. Lateral surface spinose.

**Material.** — Four incomplete tecnomorphic valves and one damaged female valve.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/66</td>
<td>broken</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/82</td>
<td>broken</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Description.** — Outline nearly complete. Greatest domiciliary convexity in ventrocentral region. Adductorial sulcus long, sigmoidal, ending slightly below preadductorial node. Preadductorial node as distinct bulb. Tecnomorphic velum appears as row of spines. Dolon broad, strongly convex, tubulose. Marginal sculpture is row of spines. Lateral surface is row of domicilium ornamented by distinct spines.

**Remarks.** — *D.? aculeata* sp. n. resembles *D. spinosa* (KNÜPFER, 1968), see also SCHALLREUTER (1984c), but differs in lacking spines at the border of the lateral and marginal surfaces of the dolon. The other characters of the species are of general *Duringia* type. *D.? aculeata* sp. n. is the oldest representative of the genus. According to JONES (1986) the remnant S3 of *Duringia mackenziensis* (COPELAND, 1982) and *D. triformosa* JONES, 1984, may indicate a quadrilobate ancestry. *D.? aculeata* sp. n. lacks S3.

**Distribution.** — Rare in the *Amorphognathus variabilis* Zone, Early Ordovician.

*Duringia* sp. 1

(Pl. 25: 6)

**Material.** — One female valve, partly damaged.

Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/192</td>
<td>1.37</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Description.** — Outline slightly preplete. Greatest domiciliary convexity in ventrocentral region, posterior of S2. S2 long and sigmoidal. Preadductorial node small, rounded. Strongly convex, tubulose velum with weakly developed dolonal spines. Marginal sculpture as row of small spines. Lateral surface granulose with small spines.

**Remarks.** — *Duringia* sp. 1 resembles *Duringia alembegensis* SCHALLREUTER, 1987 from Middle Ordovician erratic boulders, in having weakly developed dolonal spines and a long sigmoidal S2; but differs in having a more convex centroventral part of the domicilium and the presence of spines on the surface of the valves. *Duringia* sp. 1 differs from *D. triformosa* JONES, 1984 (Middle Ordovician of England and Wales) in lacking S3.

**Distribution.** — It occurs only in lower part of the *Pygodus anserinus* Zone, Middle Ordovician.
Duringia? sp. 2
(Pl. 25: 4–5)

Material. — Two tecnomorphic valves, partly damaged.

Remarks. — The ornamentation of the surface of the domicilium with spines and the velum developed as a row of spines are similar to that in other species of Duringia (D. spinosa, D. aculeata). Because of the small amount of material, the species is not named and its generic assignement remains uncertain.

Distribution. — In Mójcza it occurs only in the upper part of the Pygodus serra Zone, Middle Ordovician.

Subfamily uncertain
Genus Eochilina IVANOVA, 1964

Type species: Lacochilina (Eochilina) inviabilis IVANOVA, 1964.

Eochilina? sp.
(Pl. 33: 9–11)

Material. — 4 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/47</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/484</td>
<td>0.61</td>
<td>0.34</td>
</tr>
<tr>
<td>ZPAL O.XXV/486</td>
<td>0.72</td>
<td>0.47</td>
</tr>
</tbody>
</table>

Description. — Preplete to subamplete in lateral outline. Dorsal margin long and straight; ventral margin convex. Adductorial pit situated in dorsal half of valve is relatively shallow. Dorsal pit situated above adductorial pit is deeper than latter. Dorsal ridge weakly developed, present in antero- and posterodorsal region. Velum narrow, developed along anterior and ventral margins, lacking externally visible tubules. Surface of carapace finely reticulate. Females not found yet.

Remarks. — The specimens described show certain morphological characters, such as two pits, adductorial and dorsal, situated in dorsal half of the valve, similar to those occurring in Eochilina. The species of Eochilina described by IVANOVA (1964, 1979) are characterized by the well developed tubulous velum and dorsal ridge. In Eochilina? sp. the velum is narrow without visible tubules and the dorsal pit is deeper than the adductorial one. Eochilina? sp. resembles Eochilina (E.) clara MELNIKOVA, 1981, from the Middle Ordovician of Siberia, in possessing a similar narrow velar structure.

Distribution. — Rare in the Amorphognathus variabilis Zone, Early Ordovician.

Superfamily Hollinacea SWARTZ, 1936 (nom. transl. JAANUSSON, 1957)
Family Euprimitiidae HESSLAND, 1949 (nom. transl. KRAFT, 1962)
Subfamily Gryphiswaldensiinae SCHALLREUTER, 1968
Genus Gryphiswaldensia SCHALLREUTER, 1965

Type species: Gryphiswaldensia gryphiswaldensis SCHALLREUTER, 1965.

Gryphiswaldensia angustivelata sp. n.
(Pl. 34: 7)

Holotype: ZPAL O.XXV/485.
Type horizon: Amorphognathus variabilis Zone, Early Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin angustus — narrow, referring to the narrow velar ridge.

Diagnosis. — Gryphiswaldensia with very narrow velar ridge and weakly developed sulcal depression.

Material. — 6 valves.
Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/485</td>
<td>0.72</td>
<td>0.45</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline slightly postplete; dorsal margin long and straight. Valves moderately convex. S2 developed as weak depression. Preadductorial node rounded and small. Velar structure developed as very narrow ridge along entire free margin. Surface of domicilium finely reticulate.

**Remarks.** — *Gryphiswaldensia angustivelata* sp. n. is closely related to the stratigraphically younger *G. cavata* sp. n., but differs from the latter in a more postplete outline and weakly developed sulcal depression. It is also similar to *Gryphiswaldensia macroreticulata* (Hessland), from the Early Ordovician of Sweden (Hessland 1949), but differs from it in a more weakly developed S2 and small preadductorial node.

**Distribution.** — Rare in the upper part of the *Amorphognathus variabilis* Zone, Early Ordovician.

*Gryphiswaldensia cavata* sp. n.

*(Pl. 34: 1–5; Text-fig. 4)*

Holotype: ZPAL O.XXV/480.

Type horizon: *Pygodus serra* Zone, Middle Ordovician.

Type locality: Mójca, Holy Cross Mountains, Poland.

Derivation of the name: From Latin *cavus* - cavity, referring to the presence of a cava on the lateral surface.

**Diagnosis.** — *Gryphiswaldensia* with narrow ridge-like velar frill and small preadductorial node.

**Material.** — 349 valves, mostly well preserved.

Dimensions (figured specimens, see also size dispersion in Text-fig. 4):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/42</td>
<td>0.63</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/265</td>
<td>0.83</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/304</td>
<td>0.83</td>
<td>0.55</td>
</tr>
<tr>
<td>ZPAL O.XXV/470</td>
<td>0.74</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/480</td>
<td>0.77</td>
<td>0.45</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline almost complete to slightly preplete. Dorsal margin long and straight; free margin rounded. Preadductorial node rounded and small. Adductorial sulcus lies in front of center of valve, it is shallow and runs perpendicularly to dorsal margin. At end of sulcus a small muscle spot is present. Velar structure narrow, ridge-like, extending from anterior to posterior cardinal corners. Subvelar field narrow. Domicilial surface reticulate with special sulcal sculpture forming inner, bulb-like extension of shell material, which has only small outside opening (cavum).

**Remarks.** — A special sulcal sculpture, similar to that occurring in *G. cavata*, was described by Schallreuter (1964a, 1983d) in several Ordovician species. According to Schallreuter (1983d) it is possible that it may have had a function related to buoyancy control. *Gryphiswaldensia wilnoiensis* (Neckaja, 1952) from the Late Ordovician of Lithuania, resembles the new species in lateral outline, surface ornament and narrow velar ridge; but differs in lacking a muscle spot at the end of the sulcus. The *G. wilnoiensis* illustrated by Schallreuter (1986, Pl. 2: 4) from the Upper Ordovician erratic boulders, represents a heteromorphic valve and differs from *G. cavata* sp. n. in having a larger preadductorial node and the presence of a bend between the lateral and ventral part of the domicilium. *G. cavata* sp. n. is closely related to the stratigraphically older *G. angustivelata* sp. n., but differs from the latter by a deeper adductorial sulcus and wider velar structure.

**Distribution.** — In Mójca it occurs from the *Pygodus serra* to the *Amorphognathus tvaerensis* Zones, Middle Ordovician.

*Gryphiswaldensia gryphiswaldensis* Schallreuter, 1965

*(Pl. 34: 6)*


Material. — 65 valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/52</td>
<td>0.58</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Remarks. — *G. gryphiswaldensis* resembles *G. cavata* sp. n. in the shape of the carapace, but differs in having a wider velar ridge and a weaker sulcal depression.

Distribution. — Common in the Ordovician of the Baltic area (Backsteinkalk erratic boulders, Lithuania, Middle Ordovician) and the Holy Cross Mountains, where it occurs in Mójcza in the *Amorphognathus superbus* Zone, Middle/Late Ordovician boundary.

Genus *Steinfurtia* SCHALLREUTER, 1985

Type species: *Euprimitia macroreticulata* HESSLAND, 1949.

*Steinfurtia* sp.  
(Pl. 34: 8)

Material. — 1 tecnomorphic valve.

Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/46</td>
<td>0.68</td>
<td>0.42</td>
</tr>
</tbody>
</table>

Description and remarks. — The valve possesses slightly preplete outline; the anterior end of the valve broadly rounded; the ventral margin convex. Valve moderately convex with highest convexity behind the sulcus. Sulcus long, deep, rather broad. Preadductor nodal indistinct, small. Velum narrow, not extending to dorsal corners. Lateral surface of the domicilium ornamented with a distinct reticulation. The species resemble *S. macroreticulata* (HESSLAND) from the Early Ordovician of Sweden (HESSLAND 1949), but differs from it in having a long sulcus and a small preadductor node. It probably represents a new species but more material is needed to confirm this.

Distribution. — In Mójcza it occurs in the upper part of the *Pygodus serra* Zone, Middle Ordovician.

Family *Tvaerenellidae* JAANUSSON, 1957 (*emend. HESSLAND in BENSON et al., 1961*)  
Subfamily *Tvaerenellinae* JAANUSSON, 1957

Genus *Euprimites* HESSLAND, 1949

Subgenus *Euprimites* (*Euprimites*) HESSLAND, 1949

Type species: *Euprimites reticulogranulata* HESSLAND, 1949.

Remarks. — According to SCHALLREUTER and KRUTA (1988) *Bichilina* is a descendant of *Euprimites*. *Euprimites* and *Bichilina* may be differentiated from each other by the fact that in *Bichilina* the velar flange is entire.

*Euprimites (Euprimites) grandis* sp. n.  
(Pl. 35: 9–14)

Holotype: ZPAL O.XXXV/143.  
Type horizon: *Pygodus serra* Zone, Middle Ordovician.  
Type locality: Mójcza, Holy Cross Mountains, Poland.  
Derivation of the name: From Latin *grandis* — large.

Diagnosis. — Large *Euprimites* (greatest length of tecnomorph 2.5 mm). Sulcus deep, its ventral end curved anteroventrally. Tecnomorphs with narrow velar ridge along ventral margin, no velar ridge in instars shorter than 1.2 mm. Females with weakly convex dolon in anteroventral region. Lateral surface smooth.

Material. — 91 valves, mainly instars, among them only one incomplete female valve.
Dimensions (figured specimens):\

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/84</td>
<td>0.83</td>
<td>0.40</td>
</tr>
<tr>
<td>ZPAL O.XXV/143</td>
<td>1.04</td>
<td>0.67</td>
</tr>
<tr>
<td>ZPAL O.XXV/153</td>
<td>1.78</td>
<td>1.15</td>
</tr>
<tr>
<td>ZPAL O.XXV/154</td>
<td>0.92</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/412</td>
<td>1.17</td>
<td>0.70</td>
</tr>
<tr>
<td>ZPAL O.XXV/479</td>
<td>broken</td>
<td>0.90</td>
</tr>
</tbody>
</table>

**Description.** — Outline nearly amplete. Domicilium moderately and rather regularly convex, highest convexity in front of sulcus. Sulcus moderately wide, relatively short and deep, deepest in its ventral part; dorsally it becomes gradually shallower and before reaching dorsal margin merges into general surface of domicilium; its ventral end curved anteroventrally. Dorsal plica not developed. Preadductorial node minute, situated about at mid-height of sulcus. Large tecnomorphs (more than 1.0 mm) with narrow velar ridge along ventral margin. No such structures present in young instars. At anterior and posterior margin 5–7 small spines occur in position of admarginal structure. Right valve with admarginal ridge slightly closer to free margin than to velar structure. Left valve larger with fine contact groove. Lateral surface with very faint reticulation in younger instars and smooth in larger specimens. Only one incomplete female valve was found with weakly convex dolon in anteroventral region.

**Remarks.** — By its nearly amplete outline, deep and anteroventrally curved sulcus, smooth lateral surface, *E. (E.) grandis* sp. n. clearly differs from other known species of *Euprimites*. The tecnomorphic velar structure and the dolon seem to be like those of *E. (E.) suecicus* (THORSLUND, 1940), see also SCHALLREUTER (1973, Pl. 22: 1–3), but differ from the latter by the smooth lateral surface and deep, anteroventrally curved sulcus.

**Distribution.** — In Mőjcza it occurs from the discontinuity surface (*Pygodus serra* Zone) and is common up to the *Amorphognathus tvarenensis* Zone, Middle Ordovician.

**Genus Piretia JAANUSSON, 1957**

Type species: *Piretia geniculata* JAANUSSON, 1957.

**Piretia tenuistriata** sp. n.\
(Pl. 36: 1–7; Text-fig. 6)

Holotype: ZPAL O.XXV/58.
Type horizon: *Pygodus serra* Zone, Middle Ordovician.
Type locality: Mőjcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin *tenuis* – thin and alluding to the finely striated dolon.

**Diagnosis.** — Length of heteromorphs about 1.4–1.8 mm. Tecnomorphs with velar ridge or narrow flange. Heteromorphs with finely striated dolon.

**Material.** — 36 female valves and 91 tecnomorphic valves, some damaged.

Dimensions (figured specimens, see also size dispersion in Text-fig. 6):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/58</td>
<td>1.25</td>
<td>0.64</td>
</tr>
<tr>
<td>ZPAL O.XXV/89</td>
<td>1.12</td>
<td>0.55</td>
</tr>
<tr>
<td>ZPAL O.XXV/268</td>
<td>1.24</td>
<td>0.65</td>
</tr>
<tr>
<td>ZPAL O.XXV/409</td>
<td>1.28</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.XXV/437</td>
<td>1.51</td>
<td>0.92</td>
</tr>
<tr>
<td>ZPAL O.XXV/500</td>
<td>1.24</td>
<td>0.63</td>
</tr>
</tbody>
</table>

**Description.** — Domicilial outline slightly preplete. Domicilium rather uniformly convex, highest convexity in anterior part. Sulcus rather long, wide; ventral end rounded, strongly curved anteroventrally. Preadductor node indistinct, flattened. Tecnomorphs with velar ridge or narrow flange which is widest anteroventrally. Anteriorly, narrow velar ridge not reaching anterior cardinal corner; posteriorly velar flange decreases gradually and is obsolete in middle part of posterior margin. Females with strongly convex dolon forming a false brood pouch. Anterior end of dolon is situated at about
longitudinal line through end of sulcus; posterior end extends to posteroventral margin. Dolon is ornamented by fine striation. Left valve with fine connecting groove and marginal ridge. Right valve with admarginal ridge. Lateral surface ornamented with fine but distinct reticulation and small tubercles are scattered along velar ridge and posterior end of dolon.

Remarks. — *Piretia tenuistriata* sp. n. shows a close relationship to *Piretia geniculata* JAANUSSON from the Platyrurus Limestone of Sweden (JAANUSSON 1957). Heteromorphs of *P. tenuistriata* and *P. geniculata* are very similar, but tecnomorphs of *P. tenuistriata* differ from tecnomorphs of *P. geniculata* in having a longer carapace and narrower velar flanges especially in the anteroventral part.

Distribution. — In Mójca it occurs in the *Pygodus serra, Pygodus anserinus* and *Amorphognathus tvaerensis* Zones, Middle Ordovician.

*Piretia rara* sp. n.  
(Pl. 36: 8–11)

Holotype: ZPAL O.XXV/232.  
Type horizon: *Amorphognathus tvaerensis* Zone, Middle Ordovician.  
Type locality: Mójca, Holy Cross Mountains, Poland.  
Derivation of the name: From Latin *rarus* – rare.

Diagnosis. — *Piretia* with distinct laterovelar furrow, parallel to free margin in tecnomorphic valves. females about 1.06–1.08 mm long.

Material. — 6 tecnomorphic valves and 3 female valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/182</td>
<td>0.95</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/232</td>
<td>1.00</td>
<td>0.71</td>
</tr>
<tr>
<td>ZPAL O.XXV/233</td>
<td>1.06</td>
<td>0.68</td>
</tr>
<tr>
<td>ZPAL O.XXV/270</td>
<td>0.95</td>
<td>0.58</td>
</tr>
</tbody>
</table>


Remarks. — *Piretia rara* sp. n. is distinguished from congeneric species by the presence of a laterovelar furrow in tecnomorphic valves. The reticulate ornamentation makes *P. rara* similar to *Piretia reticulata* Quale, from the Caradoc series of the Oslo region (Quale 1980), but it differs in possessing a laterovelar furrow, narrow tecnomorphic ridge and smooth strongly convex dolon in females. *P. reticulata* probably belongs to a new genus because of its tubulous velum. *P. rara* sp. n. resembles also *Piretia commasulcata* Schallreuter from Öjlemyrflint erratic boulders of the Isle of Gotland (Schallreuter 1985a) in ornamentation of the domicilium but differs in a much better developed sulcus, lack of a ridge along the lateral and ventral surfaces of the dolon and presence of a laterovelar furrow.

Distribution. — It occurs in upper part of the *Amorphognathus tvaerensis* Zone, Middle Ordovician.

*Piretia speciosa* sp. n.  
(Pl. 35: 4–8)

Holotype: ZPAL O.XXV/151.  
Type horizon: *Pygodus serra* Zone, Middle Ordovician.  
Type locality: Mójca, Holy Cross Mountains, Poland.  
Derivation of the name: From Latin *speciosus* – well shaped, regular.

Diagnosis. — Length of heteromorphs about 0.9–1.2 mm. Sulcus strongly curved anteroventrally. Females with strongly convex dolon, ridge occurs along border of lateral and ventral surfaces of dolon.

Material. — 8 tecnomorphic valves and 3 female valves.
Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Valve Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/151</td>
<td>0.96</td>
<td>0.64</td>
</tr>
<tr>
<td>ZPAL O.XXV/275</td>
<td>1.01</td>
<td>0.67</td>
</tr>
<tr>
<td>ZPAL O.XXV/276</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/277</td>
<td>1.17</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.XXV/400</td>
<td>1.01</td>
<td>0.63</td>
</tr>
</tbody>
</table>


**Remarks.** — *Piretia speciosa* sp. n. is closely related to *Piretia clypeolaria* JAANUSSON, from the Middle Ordovician of Sweden (JAANUSSON 1957), but differs from it in having a strongly curved sulcus and a distinct ridge along the border of the lateral and ventral surfaces of the dolon. *Piretia commasulcata* SCHALLREUTER, from Upper Ordovician Öjlemyrflint erratic boulders (SCHALLREUTER 1985a) has such a ridge on the dolon, but this species differs from *P. speciosa* sp. n. by the very long shape of the domicilium and the small comma-shaped sulcus. *P. speciosa* is also similar to *Piretia rugosa* (STEUSLOFF), illustrated by SCHALLREUTER (1986, Pl. 3: 2), but differs in the nature of the ornamentation, short sulcus and by the development of the velar structure in the posterior part of the valve (in *P. rugosa* it reaches the posterior cardinal corner). *P. speciosa* is similar to *Otraczetia bulbata* gen. et sp. n. from the Early Ordovician of the Mójca section, from which it presumably evolved. It differs from the latter in lacking S1 and S3.

**Distribution.** — It occurs from the discontinuity surface (*Pygodus serra* Zone) up to the *Amorphognathus tvaerensis* Zone, Middle Ordovician.

---

**Genus Otraczetia** gen. n.

Type species: *Otraczetia bulbata* gen. et sp. n.

Derivation of the name: From Otracz – a hill close to the type locality.

**Diagnosis.** — Genus of Hollinacea having long curved adductorial sulcus and slightly marked S1 and S3. Dolon strongly convex forming false brood pouch. Prominent preadductor node.

**Remarks.** — *Otraczetia* gen. n. shows certain morphological characters, such as a strongly convex dolon, ridge-like velar structure and long anteroventrally curved S2, similar to those occurring in *Piretia* JAANUSSON, but differs in having a slightly marked S1 and S3.

*Otraczetia bulbata* sp. n.

(Pl. 35: 1–3; Textfig. 16)

Holotype: ZPAL O.XXV/200.

Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.

Type locality: Mójca, Holy Cross Mountains, Poland.

Derivation of the name: From Latin bulbus – referring to the prominent preadductor node.

**Diagnosis.** — As for the genus.

**Material.** — 23 tecnomorphic valves and 5 female valves, partly damaged.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Valve Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/200</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/201</td>
<td>1.10</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/252</td>
<td>0.92</td>
<td>0.54</td>
</tr>
</tbody>
</table>
**Description.** — Valve outline preplete. Dorsal margin long and straight. Domicilium rather moderately and regularly convex. Adductorial sulcus moderately wide, long, curved anteroventrally. Low rounded ridge surrounds sulcus. Preadductorial node large (PAN), flattish. Small S1 is present in front of preadductorial node; anteriorly surrounded by indistinct ridge. Tecnomorphic velar ridge moderately wide, widest anteroventrally, does not reach anterior cardinal corner (Text-fig. 16). Heteromorphs with strongly convex dolon with ridge between lateral and ventral surface of dolon. Marginal sculpture is row of tubercles. Lateral surface of domicilium is finely reticul-o-granulate with small tubercles. Surface of velar ridge finely granulate.

**Remarks.** — *Otraczetia bulbata* sp. n. is similar in shape of adductorial sulcus, presence of ridge between lateral and ventral surface of the dolon and narrow tecnomorphic velum to *Piretia speciosa* sp. n., but differs in having S1 and S3. *O. bulbata* probably forms the ancestral stock from which *P. speciosa* developed. The presence of weakly developed S1 and S3 is similar to that described by HESSLAND (1949) in *Tetrada teres*. HESSLAND (1949) described only tecnomorphic specimens.

**Distribution.** — It occurs in the *Amorphognathus variabilis* Zone, Early Ordovician.

**Genus Uhakiella ÖPKE, 1937**

*Uhakiella diuturna* sp. n.

(Pl. 37: 1–5; Text-fig. 7)

Holotype: ZPAL O.XXV/95.
Type horizon: *Pygodus serres* Zone, Middle Ordovician.
Type locality: Mójca, Holy Cross Mountains, Poland.
Derivation of the name: From Latin *diuturnus* – long lived, referring to the long range of the species.

**Diagnosis.** — Length of heteromorphs 1.2–1.5 mm. Anterior and posterior arches of dorsal plica weakly developed. Tecnomorphs with narrow bend-like velum in juvenile forms and narrow ridge in males and pre-adult tecnomorphs. Dolon strongly convex. Small furrow between lateral surface of domicilium and dolon is present.

**Material.** — 69 tecnomorphic valves and 4 female valves, some damaged.

Dimensions (figured specimens, see also size dispersion in Text-fig. 7):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/15</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/55</td>
<td>0.88</td>
<td>0.58</td>
</tr>
<tr>
<td>ZPAL O.XXV/95</td>
<td>1.04</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/249</td>
<td>1.24</td>
<td>0.72</td>
</tr>
</tbody>
</table>

**Description.** — Outline slightly postplete or nearly amplete. Dorsum slightly epicline. Lateral surface of domicilium rather faintly convex, highest convexity in the middle of valve. Adductorial sulcus rather deep, curved anteroventrally; its ventral end at mid-height; indistinct ridge-like elevation usually surrounds end of sulcus. Preadductorial node flattened, indistinct. Posterior arch of dorsal plica more distinct than anterior arch and slightly curved anteroventrally, both are weakly developed. Younger instars with narrow bend-like velum; males and pre-adult instars with narrow velar ridge. Dolon strongly convex, rather wide, anterior end reaching up to longitudinal line through dorsal end of adductorial sulcus, posterior end of dolon reaching up to about 2/3 of length. Row of marginal
tubercles developed along whole free margin. Ornamentation consists of closely spaced granules and rather small tubercles scattered here and there; granules continue upon lateral surface of dolon and subvelar field. Dolon has also faint radial striation. Boundary between dolon and domicilium is marked by shallow furrow.

Remarks. — *U. diuturna* sp. n. differs from other species of *Uhakiella* by its arrangement of the dorsal ridges. The ornamentation of the lateral surface resembles that of *Uhakiella magnifica* SARV, but the dorsal ridges are less distinct and the valves are smaller than in the latter species. The “einigeschnurt” velum described by SCHALLREUTER (1973) in males of *Uhakiella jaanussoni* SCHALLREUTER, is lacking in tecnomorphs of *U. diuturna* sp. n. It is possible that adult males of *U. diuturna* have not been found yet. Species similar to *Uhakiella* but without “einigeschnurt” velum, SCHALLREUTER (1983c) placed in Bromidella.

Distribution. — In Mójcza it occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis* and *Amorphognathus superbus* Zones, Middle and Late Ordovician.

*Uhakiella perrara* sp. n.

(Pl. 37: 10–11)

Holotype: ZPAL O.XXV/198.
Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin *perrarus* — very rare, referring to the small number of specimens.

Diagnosis. — Flat lateral surface. Adductorial pit small and round. Dorsal ridge along entire dorsal margin; velar ridge narrow, ending in posteroventral part.

Material. — 10 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Valve</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/107</td>
<td>0.92</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/198</td>
<td>0.92</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Description. — Outline almost amplete. Lateral surface flat. Adductorial pit rounded, rather small. Preadductorial node weakly developed. Narrow, ridge-like plica occurs along dorsal margin, it is curved ventrally in anterior and posterior ends. Velum forms ridge which terminates posteroventrally in short spine. Anteriorly, velar ridge extends to anterior cardinal corner. Ornamentation of lateral surface of domicilium consist of minute, closely spaced granules. Heteromorphic valves have been not found.

Remarks. — *Uhakiella perrara* sp. n. seems to be very close to *Uhakiella cicatricosa* SARV, from the Kunda Stage of Estonia (SARV 1959, Pl. 4: 1–4), but differs in having a distinct dorsal plica, flat lateral surface and velar ridge ending posteroventrally in a short spine. In *U. cicatricosa* the velar ridge occurs along the entire free margin.

Distribution. — Rare in the *Amorphognathus variabilis* Zone, Early Ordovician.

*Uhakiella* sp. 1

(Pl. 37: 6)

Material. — 4 tecnomorphic valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>Valve</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/426</td>
<td>1.10</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Description. — Outline almost amplete. Lateral surface of domicilium moderately convex. Adductorial sulcus curved anteroventrally, its ventral end nearly at mid-height. Preadductorial node weakly developed. Anterior and posterior arch of dorsal plica weakly developed. Velar ridge narrow, extends from anterior to posterior cardinal corners. Marginal sculpture is row of tubercles along whole free margin. Ornamentation consist of closely spaced granules and rare small tubercles.
Remarks. — *Uhakiella* sp. 1 is closely related to stratigraphically younger *Uhakiella diurna* sp. n. but differs from it in having a shallow sulcus and more convex domicilium.

Distribution. — It occurs in the upper part of the *Amorphognathus variabilis* Zone, Early Ordovician.

*Uhakiella* sp. 2

(Pl. 37: 9)

Material. — 2 tecnomorphic valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>ZPAL O.XXV/142</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.43</td>
<td>1.55</td>
</tr>
</tbody>
</table>


Remarks. — *Uhakiella* sp. 2 differs from *U. diurna* sp. n. by its strongly convex domicilium and presence of the depression above the velar bend. The most closely similar species seems to be *Uhakiella coelodesma* Öpik from the Middle Ordovician of Estonia (Öpik 1937).

Distribution. — It occurs only in the *Pygodus serra* Zone Middle Ordovician.

Genus *Bromidella* Harris, 1931

Type species: *Bromidella reticulata* Harris, 1931.

*Bromidella* sp.

(Pl. 37: 7–8)

Material. — 6 tecnomorphic valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>ZPAL O.XXV/186</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.16</td>
<td>1.55</td>
</tr>
</tbody>
</table>


Remarks. — According to Schallreuter (1973, 1983c) species of *Bromidella* are very similar to species placed in *Uhakiella*, but in typical *Uhakiella* species the males possess an “eingeschünt” velum, not present in the juvenile tecnomorphs. Specimens of *Bromidella* sp. from Mójcza are represented only by tecnomorphic valves without this special feature. The lobal and ornamental morphology of this species could be accomodated within *Bromidella*. Until additional material becomes available, particularly heteromorphs, the species is not named.

Distribution. — Rare specimens in the *Amorphognathus superbus* Zone, Late Ordovician.

Genus *Mojczella* Olempska, 1988

Type species: *Mojczella jaanussoni* Olempska, 1988
Mojczella polonica OLEMPSKA, 1988
(Pls 38: 1–3; 39: 1–3; Text-figs 8, 11)

1989. Mojczella polonica OLEMPSKA; OLEMPSKA, Text-fig. 5A.

Material. — About 65 well preserved valves of tecnomorphs and 4 of heteromorphs, and some tens of partly damaged tecnomorphs.

Dimensions (figured specimens, see also size dispersion in Text-fig. 8):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/169</td>
<td>1.01</td>
<td>0.67</td>
</tr>
<tr>
<td>ZPAL O.XXV/206</td>
<td>1.10</td>
<td>0.67</td>
</tr>
<tr>
<td>ZPAL O.XXV/208</td>
<td>1.55</td>
<td>1.01</td>
</tr>
<tr>
<td>ZPAL O.XXV/212</td>
<td>0.61</td>
<td>0.40</td>
</tr>
<tr>
<td>ZPAL O.XXV/464</td>
<td>0.77</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/467</td>
<td>0.75</td>
<td>0.47</td>
</tr>
</tbody>
</table>


Distribution. — Occurs only below the discontinuity surface, Amorphognathus variabilis Zone, Early Ordovician.

Mojczella jaanussoni OLEMPSKA, 1988
(Pls 38: 4–10; 40: 1–2; Text-figs 8, 11)

1989. Mojczella jaanussoni OLEMPSKA; OLEMPSKA, Text-fig. 5B.

Material. — About 192 complete and some tens of damaged valves of tecnomorphs and 4 fragments of valves of heteromorphs.

Dimensions (figured specimens, see also size dispersion in Text-fig. 8):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/18</td>
<td>0.95</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/24</td>
<td>1.89</td>
<td>1.24</td>
</tr>
<tr>
<td>ZPAL O.XXV/185</td>
<td>2.03</td>
<td>1.37</td>
</tr>
<tr>
<td>ZPAL O.XXV/213</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/214</td>
<td>1.13</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/218</td>
<td>1.19</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/219</td>
<td>0.72</td>
<td>0.49</td>
</tr>
<tr>
<td>ZPAL O.XXV/221</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/530</td>
<td>0.72</td>
<td>0.45</td>
</tr>
</tbody>
</table>


Distribution. — In Mójcz a it occurs from the Pygodus serr a up to Pygodus anserinus Zones, Middle Ordovician.

Mojczella sanctacrucensis OLEMPSKA, 1988
(Pls 38: 11–12; 40: 3–4; Text-figs 8, 11)

1989. Mojczella sanctacrucensis OLEMPSKA; OLEMPSKA, Text-fig. 5C.

Material. — 36 complete and some tens of damaged tecnomorphic valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 8):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/210</td>
<td>1.28</td>
<td>0.88</td>
</tr>
<tr>
<td>ZPAL O.XXV/260</td>
<td>1.80</td>
<td>1.26</td>
</tr>
<tr>
<td>ZPAL O.XXV/459</td>
<td>1.10</td>
<td>0.72</td>
</tr>
</tbody>
</table>

**Distribution.** — In Mójcza it occurs in the *Amorphognathus tvaerensis* and *Amorphognathus superbus* Zones, Middle Ordovician. In the Baltic area it occurs in the Middle Ordovician of Lithuania.

*Mojezella*? sp.
(Pl. 26: 8–9)

**Material.** — 4 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/241</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/451</td>
<td>0.83</td>
<td>0.52</td>
</tr>
</tbody>
</table>

**Description.** — Domiciliary outline almost complete. Domicilium in ventral view rather faintly convex. Preadductorial node and adductorial sulcus weakly developed. U-shaped crest surrounds sulcus and preadductorial node; it extends to dorsal margin and is slightly curved close to dorsal margin. Dorsal plica absent. Tecnomorphs with moderately wide vela ridge, anteriorly it extends to anterior cardinal corner; posteroventral end with spine-like projection. Small spine present in postero-dorsal region. Marginal sculpture is row of marginal tubercles. Lateral surface of domicilium covered by minute closely spaced granules. Females not found yet.

**Remarks.** — Because of the poor state of preservation it is difficult to confirm if the vela structure is undulate or not. The tubules are not clearly visible. This species is similar in the development of the vela structure and presence of postero-dorsal spine to *Mojezella sanctacrucensis*, but differs from it in its thick crest and absence of dorsal plica.

**Distribution.** — It occurs only in the *Amorphognathus superbus* Zone, Late Ordovician.

*Tvaerenellidae* sp. A
(Pl. 28: 10–11)

**Material.** — 1 partly broken female valve and 1 tecnomorphic valve.

Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/91</td>
<td>0.80</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/222</td>
<td>broken</td>
<td>0.70</td>
</tr>
</tbody>
</table>

**Description.** — Unfortunately the material is too badly preserved to be described in detail, although it is sufficient to allow the following remarks to be made: lateral outline almost complete; dorsal margin long and straight; sulcus distinct, pit-like. Vela ridge in tecnomorphic valve reaching anterior cardinal corner, terminating in posteroventral spine. Heteromorphic valve broken, with weakly convex, broad dolon reaching upper part of anterior margin. Lateral surface smooth.

**Remarks.** — The specimens described show certain morphological characters, such as vela structure, similar to those occurring in *Eoaquapulex frequens* (Steusloff), illustrated by Schallreuter (1986, Pl. 3: 1). The tecnomorphic valve is similar to specimens of *Eographiodactylus sulcatus* Schallreuter from the Upper Ordovician Öjlemyrflint boulders of Gotland (Schallreuter 1975b). More material is needed for determination of this species.

**Distribution.** — Uppermost *Pygodus serra* and lowermost *Pygodus anserinus* Zones, Middle Ordovician.

Family *Ctenonotellidae* Schmidt, 1941
Subfamily *Tallinellinae* Schallreuter, 1976
Genus *Quadritia* Schallreuter, 1966

Type species: *Quadritia (Quadritia) quadrispina* (Krause, 1892).

*Quadritia*? sp.
(Pl. 44: 6)

**Material.** — Two valves, partly damaged.
Dimensions (figured specimen):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/197</td>
<td>0.97</td>
<td>0.59</td>
</tr>
</tbody>
</table>

**Description.** — Outline almost complete. Two spines are present in anterior part of valve, one near dorsal margin, second in mid-height. Preaductorional node weakly developed. Adductorional sulcus as shallow depression. Centro-ventral spine is present below sulcus. In posterior part of valve posteroventral spine is present. Anterodorsal parts of valves are broken. Velar ridge narrow, along entire free margin. Lateral surface finely reticulo-granulate.

**Remarks.** — The specimens described shows certain morphological characters such as the anterior lobe in the shape of two spines, and the presence of spines in the ventral part similar to those occurring in *Quadritia*. In *Quadritia (Krutatia)* four dorsal nodes or spines and four ventral nodes are present, in *Quadritia (Quadritia)* the dorsal spines are lost during phylogeny (Schallreuter 1981a; Vannier and Schallreuter 1983; Vannier 1986b). More well preserved material is needed for determination of this species.

**Distribution.** — Rare in the *Amorphognathus variabilis* Zone, Early Ordovician.

---

Subfamily **Wehrliinae** Schallreuter, 1965  
Genus **Rakverella** Öpik, 1937  
Subgenus **Rakverella (Pectidolon)** Schallreuter, 1966

Type species: *Tetradella perornata* Öpik, 1937.

*Rakverella (Pectidolon) antica* sp. n.  
(Pl. 26: 12–14)

Holotype: ZPAL O.XXV/196.  
Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.  
Type locality: Mójcza, Holy Cross Mountains, Poland.  
Derivation of the name: From Latin *anticus* — old, ancient.

**Diagnosis.** — L1 and L3 forming U-shaped crista, and L4 as single crest parallel to posterior margin. Dolon with row of perifere spines having grill-like appearance. Small preadductorional node.

**Material.** — 36 tecnomorphic valves, some damaged, and 2 incomplete female valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/196</td>
<td>1.00</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline subamplete to slightly preplete. Dorsal margin long and straight. Preaductorional node weakly developed, spine-like. Sulcal depression slightly marked. L1 and L3 forming U-shaped cristate ridge extending from dorsal margin near anterior corner, to dorsal margin slightly behind mid-length. In ventral part U-shaped crista extending almost to ventral margin. L4 as crest extending from dorsal margin and ending near ventral margin, parallel to posterior margin. Velar structure in tecnomorphs as row of spines. Females with long, slightly convex dolon, with row of peripheral spines more or less perpendicular to contact-plane forming outer antral fence. Marginal sculpture formed by row of small spines. Lateral surface granulose.

**Remarks.** — *Rakverella (P.) antica* sp. n. is closely related to *R. (P.) perornata* Öpik, from the Kukruse Stage of Estonia (Öpik 1937), but differs in a having very small preadductorional node and differs also in the shape of the crests.

**Distribution.** — In Mójcza it occurs in the *Amorphognathus variabilis* Zone, Early Ordovician.

---

Subfamily **Steusloffinae** Schallreuter, 1966  
Genus **Rigidella** Öpik, 1937

Type species: *Steusloffia miniš* Öpik, 1935.
Rigidella dubia sp. n.
(Pl. 25: 7–8)

Holotype: ZPAL O.XXV/227.
Type horizon: Amorphognathus variabilis Zone, Early Ordovician.
Type locality: Mőjcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin dubius – doubtful, undecided, not typical representative of the genus.

Diagnosis. — Rigidella with weakly developed dorsal ridge and only partly developed C1 and C3 in dorsal region of valve.
Material. — 3 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/227</td>
<td>0.83</td>
<td>0.55</td>
</tr>
<tr>
<td>ZPAL O.XXV/301</td>
<td>1.01</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Description. — Outline of valves is complete to slightly preplete. Dorsal margin long and straight. Ventral margin slightly rounded. Domicilium moderately convex. Highest convexity lies in posteroventral part of valve. Adductorial sulcus sigmoidal, its deepest part is situated in center of valve. S1 developed as very faint sulcus. Preadductorial node relatively large, constricted ventrally. Anterior cardinal angle much larger than posterior. L1 flattened, narrow; L3 strongly convex, especially in ventral region. C1 and C3 unclear, developed only in dorsal part of valve. Dorsal ridge weakly developed. Velar ridge narrow, developed in anteroventral and ventral part. Marginal sculpture is row of tubercles. Lateral surface of domicilium covered by small granules.

Remarks. — Rigidella dubia sp. n. resembles Rigidella levis SARV from the late Kunda Stage of Estonia (SARV 1959) and N-E Poland (SZTEIN 1985) in development of C1 and C3, but differs in lacking C2 on the preadductorional node and in the weakly developed dorsal ridge. It differs from Rigidella initialis SARV from the Kunda Stage of Estonia (SARV 1959) in having C1 and C3 only in the dorsal part of the valve.

Distribution. — Rare in the Amorphognathus variabilis Zone, Early Ordovician.

Subfamily uncertain
Genus Telegraphia gen. n.

Type species: Telegraphia prima sp. n.
Derivation of the name: From Telegraf – name of a hill near the type locality.

Diagnosis. — Ctenonotellidae with large, elongate preadductorional node; C1 as short ridge; C3 connected with preadductorional node in ventral part; C4 as U-shaped ridge. S2 deep, directed anteroventrally. Velar flange broad, botulate antrum.

Remarks. — This genus appears to be morphologically related to certain Early Ordovician hollihnaeans, such as Steusloffina and Pseudostrepula, but differs from them in having a broad velar flange; the shape of C3 and C4 and in the absence of C2 on the preadductorional node.

Telegraphia prima gen. et sp. n.
(Pl. 25: 13–14; Text-fig. 17)

Holotype: ZPAL O.XXV/193.
Type horizon: Amorphognathus variabilis Zone, Early Ordovician.
Type locality: Mőjcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin primus – first.

Diagnosis. — As for the genus.
Material. — 9 tecnomorphic valves and 1 female valve, partly damaged.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/193</td>
<td>broken</td>
<td>0.76</td>
</tr>
<tr>
<td>ZPAL O.XXV/290</td>
<td>broken</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Description. — Valve outline slightly preplete. Dorsal margin long, straight. Preadductorial node elongate, large. S1 developed as faint groove, parallel to C1. S2 relatively deep, extending to mid-height of valve, directed anteroventrally. S3 narrow, long. C1 as short ridge extending slightly below preadductorial node. C3 parallel to S2 and connected with preadductorial node in ventral part. C4 U-shaped, parallel to C3, not extending dorsal margin. Velum broad, extending from anterior cardinal corner to posteroventral region (Text-fig. 17). Heteromorph velum slightly convex. Botulate antrum. Lateral surface granulose.

Remarks. — As for the genus.

Distribution. — Known only from the Amorphognathus variabilis Zone, Early Ordovician.

Family Tetradellidae Swartz, 1936
Subfamily Tetradellinae Swartz, 1936 (nom. transl. Kay, 1940)
Genus Ogmoopsis Hessland, 1949
Subgenus Ogmoopsis (Ogmoopsis) Hessland, 1949

Type species: Ogmoopsis nidulifera Hessland, 1949.

Ogmoopsis (Ogmoopsis) sp.
(Pl. 41: 1–2)

Material. — Two tecnomorphic valves, partly damaged.

Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/67</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/205</td>
<td>1.19</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Description. — Valves slightly preplete in lateral outline. Hinge line long. Transverse convexity greatest ventrally. S1 narrow and sigmoidal, in ventral part directed much forward; S2 — broad, deep and sigmoidal; S3 fairly narrow. L1 — narrow, elongate and claviform, extending to dorsal margin, in dorsal part slightly rounded, ventral end tapering; outer surface rounded. L2 — in dorsal part with small preadductorial node, ventrally slightly sigmoidal. L3 — fairly broad, broadest in ventral half, slightly sloping towards anteriorly in ventral half. L4 — sloping towards anterior, bordered in posterior part by histial flange. All lobes connected ventrally by histial flange. Velar ridge narrow, extending from anterior to posterior cardinal corners. Ventral region of tecnomorphs slightly concave between histial flange and velar ridge. Valve surface smooth.

Remarks. — The specimens described differ from Ogmoopsis alata Sarv from the Early Ordovician of Estonia (Sarv 1959) in having a broader S3, straight and narrow S1 and broader L1, extending more ventrally. Ogmoopsis (O.) sp. most resembles Ogmoopsis nidulifera Hessland from the Early Ordovician of Sweden (Hessland 1949), but differs from the latter in having a flatter surface of the lobes and shallower sulci. The taxonomic position of the form is uncertain since females are unknown.

Distribution. — Only in the basal part of the section in the Amorphognathus variabilis Zone, Early Ordovician.

Subfamily Perspicillinae Schallreuter, 1967
Genus Sigmobolbina Henningsmoen, 1953

Type species: Entomis oblonga var. kuckersiana Bonnema, 1909.
Sigmobolbina lysicae sp. n.
(Pl. 43: 15–17)

Holotype: ZPAL O.XXV/137.
Type horizon: Pygodus serra Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.

Derivation of the name: From Lysica – the highest peak in the Holy Cross Mountains.

Diagnosis. — Species of Sigmobolbina with heteromorphs 1.2–1.3 mm long. Posterior cardinal angle greater than anterior. S2 wide, long and sigmoidal. Preadductorial node weakly developed. Histium distinct, extending from anterior cardinal corner to posteroventral region. Surface smooth.

Material. — 4 tecnomorphic valves and 2 female valves, partly damaged.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/137</td>
<td>1.28</td>
<td>0.67</td>
</tr>
<tr>
<td>ZPAL O.XXV/138</td>
<td>1.28</td>
<td>0.70</td>
</tr>
<tr>
<td>ZPAL O.XXV/152</td>
<td>broken</td>
<td>0.72</td>
</tr>
</tbody>
</table>


Remarks. — Sigmobolbina lysicae sp. n. resembles Sigmobolbina cyclopa Schallreuter, 1964b and Sigmobolbina nana Schallreuter, 1984a, from Middle Ordovician erratic boulders, but differs in having a broader sulcus and more prominent preadductorial node. From Sigmobolbina agger Schallreuter, 1985b, it differs in its smooth lateral surface and deeper antrum.

Distribution. — It occurs only in lower part of the Pygodus serra Zone, Middle Ordovician.

Genus Pentagona Schallreuter, 1964

Type species: Sigmobolbina pentagona Jaanusson, 1957.

Pentagona cf. pentagona Jaanusson, 1957
(Pl. 43: 3–7)

Material. — 30 tecnomorphic valves and 6 heteromorphic valves, partly damaged.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/183</td>
<td>1.19</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/245</td>
<td>0.99</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/246</td>
<td>broken</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/401</td>
<td>0.92</td>
<td>0.60</td>
</tr>
<tr>
<td>ZPAL O.XXV/493</td>
<td>1.17</td>
<td>0.59</td>
</tr>
</tbody>
</table>


Remarks. — The morphology of the complete larval specimens is practically identical with that of P. pentagona, but differs in the relatively longer carapace. Because of this and the lack of complete female valves specific identification is uncertain.

Distribution. — In Mójcza it occurs in the Pygodus serra and Pygodus anserinus Zones, Middle Ordovician.
Genus *Ceratobolbina* JAANUSSON, 1966

Type species: *Signobolbina monoceratina* JAANUSSON, 1957.

*Ceratobolbina monoceratina* (JAANUSSON, 1957)  
(Pl. 43: 8–14)

1966. *Ceratobolbina monoceratina* (JAANUSSON); JAANUSSON, p. 17.

**Material.** — 33 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/6</td>
<td>1.01</td>
<td>0.59</td>
</tr>
<tr>
<td>ZPAL O.XXV/17</td>
<td>0.85</td>
<td>0.48</td>
</tr>
<tr>
<td>ZPAL O.XXV/22</td>
<td>0.72</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/57</td>
<td>0.80</td>
<td>0.48</td>
</tr>
<tr>
<td>ZPAL O.XXV/89</td>
<td>0.91</td>
<td>0.61</td>
</tr>
<tr>
<td>ZPAL O.XXV/491</td>
<td>1.06</td>
<td>0.58</td>
</tr>
<tr>
<td>ZPAL O.XXV/492</td>
<td>1.10</td>
<td>0.54</td>
</tr>
</tbody>
</table>

**Remarks.** — For a full discussion see JAANUSSON (1966). Tecnomorphic valves are morphologically identical with the type specimens. No adult female valves have been found in the Mójczka Limestone.

**Distribution.** — In Mójczka it occurs in the *Pygodus serra* and *Pygodus anserinus* Zones, Middle Ordovician.

Subfamily *Glossomorphitinae* HESSLAND, 1954

Genus *Collibolbina* SCHALLREUTER, 1967

Type species: *Lomatobolbina collis* SCHALLREUTER, 1964.

*Collibolbina sigmoidea* (JAANUSSON, 1957)  
(Pl. 42: 4–6)

1957. *Signobolbina sigmoidea* sp. n.; JAANUSSON, p. 392, Pl. 11: 16–20. Text-fig. 43B.  
1967b. *Collibolbina sigmoidea* (JAANUSSON); SCHALLREUTER, p. 442.

**Material.** — 30 tecnomorphic valves and 8 female valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/488</td>
<td>1.46</td>
<td>0.81</td>
</tr>
<tr>
<td>ZPAL O.XXV/489</td>
<td>1.47</td>
<td>0.85</td>
</tr>
<tr>
<td>ZPAL O.XXV/490</td>
<td>1.37</td>
<td>0.79</td>
</tr>
</tbody>
</table>

**Remarks.** — *Collibolbina sigmoidea* (JAANUSSON) differs from other species of the genus mainly by the broad posteroventral lobe without spine or node and by having a narrow and deep ventral part of the sulcus.

**Distribution.** — In Mójczka it occurs only in the *Amorphognathus tvaerensis* Zone, Middle Ordovician. In the Ordovician of the Baltic area it occurs in the Middle Ordovician (Crassicauda limestone, uppermost Schroeteri limestone and lowermost Ludibundus limestone) of land and Östergötland of Sweden.

*Collibolbina barbarae* sp. n.  
(Pl. 42: 1–3)

Holotype: ZPAL O.XXV/65.

Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.
Type locality: Mojcza, Holy Cross Mountains, Poland.

Derivation of the name: In Honour of Dr. Barbara Zbikowska (Institute of Geological Sciences, Polish Academy of Sciences, Warsaw).

**Diagnosis.** — S2 long and sigmoidal. Preadductorial node weakly developed. Posteroventral lobe distinct, without node. Flange-like velum in females. Tecnomorphs with ridge-like velum in anterior and partly in ventral region. Surface tuberculate.

**Material.** — 71 tecnomorphic and 12 female valves, some of them damaged.

**Dimensions (figured specimens):**

<table>
<thead>
<tr>
<th>ZPAL O.xxV/64</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.90</td>
<td></td>
<td>0.47</td>
</tr>
<tr>
<td>ZPAL O.xxV/65</td>
<td>1.37</td>
<td>0.68</td>
</tr>
<tr>
<td>ZPAL O.xxV/522</td>
<td>1.40</td>
<td>0.69</td>
</tr>
</tbody>
</table>

**Description.** — Females strongly preplete; tecnomorphs preplete in lateral outline. Domicilium moderately long. S2 long, sigmoidal, reaching below mid-height, widens towards dorsal margin. Preadductorial node weakly developed. Posteroventral lobe convex, without node. Anteroventral lobe flat. Velum flange-like in females, widest anteroventrally; ridge-like in tecnomorphs, extending from anterior cardinal corner to ventral region. Velum approximately parallel with free margin. In postero-dorsal corner small elevation of valve is visible. Marginal sculpture is ridge. Lateral surface tuberculate.

**Remarks.** — *Collibolbina barbarae* sp. n. differs from other species of *Collibolbina* in the tuberculate surface of the domicilium and narrow velum, extending only to the middle part of ventral margin in tecnomorphs.

**Distribution.** — In Mojcza it occurs only in the *Amorphognathus variabilis* Zone, Early Ordovician.

*Collibolbina postaculeata* sp. n.

(Pl. 42: 8–12)

**Holotype:** ZPAL O.xxV/63.

**Type horizon:** *Pygodus anserinus* Zone, Middle Ordovician.

**Type locality:** Mojcza, Holy Cross Mountains, Poland.

**Derivation of the name:** From Lat. *post* — posterior and *aculeus* — spine, referring to the spine-like projection on the posteroventral lobe.

**Diagnosis.** — *Collibolbina* species with weak preadductorial node; female velum with narrow ridge along border of flange; posteroventral lobe prominent with spine-like posterior termination.

**Material.** — 70 tecnomorphic and 11 female valves, some damaged.

**Dimensions (figured specimens):**

<table>
<thead>
<tr>
<th>ZPAL O.xxV/50</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.55</td>
<td></td>
<td>0.92</td>
</tr>
<tr>
<td>ZPAL O.xxV/63</td>
<td>1.56</td>
<td>0.93</td>
</tr>
<tr>
<td>ZPAL O.xxV/174</td>
<td>1.55</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.xxV/280</td>
<td>broken</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.xxV/487</td>
<td>1.19</td>
<td>0.59</td>
</tr>
</tbody>
</table>

**Description.** — Females moderately high and preplete. Tecnomorphs moderately long and preplete in lateral outline. Cardinal angles greater than 90°. Preadductorial node weakly developed. S2 sigmoidal, weaker ventrally. Prominent posteroventral lobe with spine-like posterior termination. Ridge-like velum in tecnomorphs extending from anterior cardinal corner, reduced to indistinct ridge in posteroventral region. Female velum is flange, forming slightly convex dolon, widest anteroventrally, with narrow ridge parallel to margin. Velum reduced to narrow ridge in posteroventral region and obsolete in posterior region. Admarginal antrum. Marginal sculpture developed as narrow ridge. Lateral surface smooth.

**Remarks.** — *Collibolbina postaculeata* sp. n. is closely related to *Collibolbina collis* SCHALLREUTER from the Middle Ordovician erratic boulders (SCHALLREUTER 1967b), but differs in having a
narrow ridge on the female velum, and a more prominent node on the posteroventral lobe. This species is homeomorphic with many unisulcate palaeocope species which have a posteroventral lobe and spine and a flange-like velum (cf. Schallreuter 1981b).

**Distribution.** — In Mójca it occurs from the discontinuity surface (*Pygodus serra* Zone) and is quite common up to the *Amorphognathus superbus* Zone, Middle and Late Ordovician.

*Collibolbina?* sp.
(Pl. 42: 13)

**Material.** — One female valve.

**Dimensions:**

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/53</td>
<td>1.00</td>
<td>0.72</td>
</tr>
</tbody>
</table>


**Remarks.** — It differs from other species of *Collibolbina* in the flat, weakly developed posteroventral lobe and spur at the end of the velar flange.

**Distribution.** — In Mójca it occurs only in the *Pygodus serra* Zone, Middle Ordovician.

**Genus Glossomorphites** Hessland, 1954

**Subgenus Glossomorphites (Glossomorphites)** Hessland, 1954

Type species: *Glossopsis lingua* Hessland, 1949.

*Glossomorphites (Glossomorphites) kielcensis* sp. n.
(Pl. 41: 11–13; Text-fig. 18)

**Holotype:** ZPAL O.XXV/225.
**Type horizon:** *Amorphognathus variabilis* Zone, Early Ordovician.
**Type locality:** Mójca, Holy Cross Mountains, Poland.
**Derivation of the name:** From Kielce – city in the Holy Cross Mountains.

**Diagnosis.** — *Glossomorphites* of fairly small size, females 1.1–1.2 mm long. L1 and L3 rather broad, L2 narrow. S2 long and deep, S3 – fissum-like. Surface minutely but distinctly pitted.

**Material.** — 25 tecnomorphic valves and 4 female valves, mostly of them damaged.

**Dimensions (figured specimens):**

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/225</td>
<td>1.10</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/226</td>
<td>0.80</td>
<td>0.52</td>
</tr>
</tbody>
</table>

**Description.** — Lateral outline preplete. Carapace of fairly small size. Dorsal margin straight and long; anterior margin widely curved; posterior one more convex; ventral margin convex. Anterodorsal angle slightly more obtuse than posteroeceral. L1 rather broad, dorsal end not protruding over dorsal margin. S1 long but shallow and not very distinct, perpendicular to dorsal margin. L2 long, narrow, extending practically to dorsal margin with small weakly developed preadductorial node in upper part. S2 long, deep and broad, sigmoidal in females. L3 broadest in dorsal part and distinctly diminishing in breadth in ventral direction, ventral half slightly arched. S3 fissum-like, weakly developed. L4 broad and gently arched in dorsal half, ventral half narrower and diminishing in breadth ventrally. Velar ridge in tecnomorphs as ridge extending from anterior cardinal corner, reduced to indistinct ridge in posterior part. Histiovelum flange in females, widest anteroventrally, starts slightly below anterior cardinal corner and ends in posteroventral part (Text-fig. 18). Antrum without inner antral fence. Marginal sculpture consist of row of fused spines. Lateral surface minutely but distinctly pitted.

**Remarks.** — *Glossomorphites (G.) kielcensis* sp. n. resembles *Glossomorphites (G.) digitatus* (Krause, 1889), (= *G. lingua* Hessland, 1949, = *G. clavatus* Hessland, 1949), but differs from it
in the shape of S1 and S3 and the flat surface of the lobes. *G. (G.) kielcensis* sp. n. resembles also *G. (G.) mytoensis* SCHALLREUTER and KRÜTA, 1988, from the Klabava Formation (Early Ordovician) of Bohemia, but differs in having broader lobes L1 and L3 and fissum-like S3.

**Distribution.** — In Mójca it occurs only in the *Amorphognathus variabilis* Zone, Early Ordovician.

**Glossomorphites (Glossomorphites) sp.**

(Pl. 41: 3–5)

**Material.** — 10 tecnomorphic valves and 4 female valves, all female valves damaged.

**Dimensions (figured specimens):**

<p>| | | |</p>
<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/194</td>
<td>L</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>broken</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/230</td>
<td>1.15</td>
<td>0.66</td>
</tr>
</tbody>
</table>


**Remarks.** — *G. (G.) sp.* differs from *G. (G.) kielcensis* sp. n. mainly by the lack of S3, convex L3 + L4, smooth surface and deep antrum.

**Distribution.** — It occurs in the *Amorphognathus variabilis* Zone, Early Ordovician.

**Genus Hesslandella HENNINGSMOEN, 1953**

Type species: *Ctenenioma macroreticulata* HESSLAND, 1949.

**Hesslandella sztejnae** sp. n.

(Pl. 41: 6–10; Text-fig. 19)

**Holotype:** ZPAL O.XXV/203.

**Type horizon:** *Amorphognathus variabilis* Zone, Early Ordovician.

**Type locality:** Mójca, Holy Cross Mountains, Poland.

**Derivation of the name:** In honour of Dr. Janina SZTEIN, from the State Geological Institute, Warsaw.

**Diagnosis.** — Hesslandella with females 1.1–1.3 mm long. Preadductorial node weakly developed. Histiovelum widest anteroventrally. Tecnomorphic velum as narrow ridge. S2 long, sigmoidal.

**Material.** — 66 tecnomorphic and 12 heteromorphic valves, part of them damaged.
Fig. 19.
Schematic diagrams of lateral and ventral view of right valves of *Hesslandella sztejnae* sp. n. a. adult female, b. and c. pre-adult females, d. tecnomorph.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/75</td>
<td>1.19</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/203</td>
<td>1.10</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/204</td>
<td>0.92</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/309</td>
<td>broken</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/527</td>
<td>0.66</td>
<td>0.42</td>
</tr>
</tbody>
</table>

**Description.** — Outline preplete. Cardinal corners distinct with obtuse cardinal angles; anterior angle more obtuse than posterior. Hinge line long to very long. S2 sigmoidal, long. Preadductorial node weakly developed. Histiovelum, flange-like in females and widest anteroventrally; ridge-like in ventral region of tecnomorphs and extending from anterior cardinal corner. Velum reduced to indistinct ridge in posterior region, runs parallel with free margin. Supravelar furrow indistinct anteroventrally. Pre-adult females have partially developed narrow histial ridge parallel to velar ridge. It is longer in larger specimens (Text-fig. 19). Below histial ridge, velum weakly developed as indistinct ridge. Marginal sculpture is ridge. In right valves admarginal ridge is present; in left valves, marginal ridge is close to free margin and contact groove is visible on internal surface of valve. Valve surface generally smooth, but well preserved specimens show fine reticulation.

**Remarks.** — Tecnomorphs of *Hesslandella sztejnae* sp. n. resemble specimens of *Hesslandella macroreticulata* (HESSLAND) in lateral appearance, but differ in the weakly developed preadductorial
node. Unfortunately HESSLAND (1949) figured only tectomorphic valves. From *Hesslandella panis* SCHALLREUTER, 1964 (Backsteinkalk erratic boulders, SCHALLREUTER 1964c, 1983b), *H. sztejnae* differs in a longer S2 and presence of a supravelar furrow.

**Distribution.** — In Mójcza it occurs below the discontinuity surface (*Amorphognathus variabilis* Zone), Early Ordovician.

Genus *Hippula* Tromelin et LEBESCONTE, 1876
Subgenus *Hippula* (*Cetona*) SCHALLREUTER, 1964

Type species: *Oecematobolbina* (*Cetona*) cetona SCHALLREUTER, 1964.

*Hippula* (*Cetona*) sp.
(Pl. 41: 14)

**Material.** — Two valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/195</td>
<td>1.28</td>
<td>0.72</td>
</tr>
</tbody>
</table>


**Remarks.** — The morphology and phylogenetic relationships of species of *Hippula* have been fully discussed by VANNIER, KRÚTA, and MAREK (1987). The specimens described resemble *Hippula* (*C.*) *turr*is (SCHALLREUTER) from upper Viruan erratic boulders (SCHALLREUTER 1967b, cf. also SCHALLREUTER 1984b) but differ in the nature of the posteroventral lobe. In the latter, the posteroventral lobe ends in a long reticulate spine.

**Distribution.** — In Mójcza it occurs only in the *Pygodus serra* Zone, Middle Ordovician.

Genus *Vittella* SCHALLREUTER, 1964

Type species: *Vittella vittensis* SCHALLREUTER, 1964.

*Vittella* sp.
(Pl. 42: 7)

**Material.** — One tecnomorphic valve.

Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/115</td>
<td>1.20</td>
<td>0.70</td>
</tr>
</tbody>
</table>


**Remarks.** — Because of the poor state of preservation, the species is not named. It resembles *Vittella? jemtlandica* (THORSLUND) from the lower *Chasmops* limestone (THORSLUND 1940). According to SCHALLREUTER (1983a) *V.? jemtlandica* may form the basis of a new genus because of its comma-shaped sulcus and admarginal antrum.

**Distribution.** — In Mójcza it occurs only in the *Pygodus serra* Zone, Middle Ordovician.

Genus *Adamczakites* gen. n.

Type species: *Adamczakites paucus* gen. et sp. n.

Derivation of the name: In honour of Dr. Franciszek ADAMCZAK from Stockholm.
Diagnosis. — L1 + L2 – wide and flat with weakly developed preadductorial node. S2 very broad, sigmoidal, extending from dorsal margin, in ventral part protruding over ventral margin. L3 convex, narrow in ventral region, with indistinct node-like elevation in posteroverentral part. S3 fissum-like, parallel to posteroverentral margin. L4 narrow in ventral part, parallel to S3. Connecting lobe protruding over ventral margin.

Remarks. — This genus appears to be morphologically related to the Early Ordovician Aulacopsis HESSLAND in general pattern of L–S ornamentation, but differs in having a broad and flat L1 + L2, very wide S2, connecting lobe protruding over ventral margin in tecnomorphs, and lack of fissum in front of the sulcus.

Adamczakites paucus sp. n.
(Pl. 43: 1–2)

Holotype: ZPAL O.XXV/10.
Type horizon: Pygodus serra Zone, Middle Ordovician.
Type locality: Mójczka, Holy Cross Mountains, Poland.
Derivation of the name: From Latin paucus – few, little, referring to the rarity of the species.

Diagnosis. — As for the genus.
Material. — 5 tecnomorphic valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/10</td>
<td>1.24</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/274</td>
<td>broken</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Description. — Valve outline slightly preplete. Hinge line long and straight. Anterodorsal angle slightly more obtuse than posterodorsal. Anterior margin more rounded than posterior; ventral margin moderately convex. Transverse convexity greatest in ventral region. L1 + L2 wide, in dorsal region flat, dorsal part of L2 forming weak preadductorial node. L3 convex, sloping towards anterior, with weakly developed node-like elevation in posteroverental part. L4 narrow, parallel to posteroverental margin. All lobes joined by connecting lobe protruding over ventral margin. S3 narrow, fissum-like, sloping towards anterior. Velum as flange-like keel (or rounded ridge) from anterior to posterior cardinal corner. Marginal sculpture as narrow ridge. Surface of lobes finely reticulate.

Remarks. — Adamczakites paucus sp. n. is distinguished from other Tetradellidae by its L–S ornament.

Distribution. — In Mójczka it occurs in the Pygodus serra and Amorphognathus tvaerensis Zones, Middle Ordovician.

Suborder Binodicopa SCHALLREUTER, 1972 (emend. SCHALLREUTER, 1978)
Superfamily Drepanellacea ÜLRICHT bassler, 1923 (nom. transl. POLENOVA et ZANINA, 1960)
Family Bolliidae BOUČEK, 1936 (nom. transl. SCOTT and WAINRIGHT in BENSON et al., 1961)
Genus Klimphores SCHALLREUTER, 1966

Type species: Klimphores planus SCHALLREUTER, 1966.

Remarks. — The revision of the Ordovician forms of Klimphores was conducted by SCHALLREUTER (1968a). Taking into account differences in partition of the anterior nodal complex, he distinguished among the known species of Klimphores two genera, Klimphores and the new genus Laterophores. According to SCHALLREUTER (1968a) the new genus is distinguished by the distinct bipartition of the anterior nodal complex. The partition of the anterior nodal complex in many known species of Klimphores, does not indicate to which genus they belong. Moreover, in Klimphores-like species [K. (K.) subplanus and K. (K.) vannieri] occurring in the Mójczka Limestone, the partition of the anterior nodal complex displays a great intraspecific variability. Therefore, the genus Laterophores is considered as a subgenus of Klimphores.
**Klimphores (Klimphores) subplanus** sp. n.  
(Pl. 45: 4–8; Text-fig. 10)

**Holotype**: ZPAL O.XXV/496.  
**Type horizon**: *Pygodus anserinus* Zone, Middle Ordovician.  
**Type locality**: Mójca, Holy Cross Mountains, Poland.  
**Derivation of the name**: The name suggests similarity to *Klimphores planus* SCHALLREUTER.

**Diagnosis**. — Valves up to 0.75 mm long. Anterior cardinal corner more rounded than posterior cardinal corner. Anterior nodal complex slightly divided into anterodorsal and anterocentral node. Preadductorial node totally incorporated in anterior nodal complex.

**Material**. — 607 valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 10):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/76</td>
<td>0.63</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/278</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/461</td>
<td>0.72</td>
<td>0.50</td>
</tr>
<tr>
<td>ZPAL O.XXV/495</td>
<td>0.68</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/496</td>
<td>0.63</td>
<td>0.36</td>
</tr>
</tbody>
</table>

**Description**. — Lateral outline more or less amplete. Hinge line straight and moderately long. Lateral surface moderately convex. Nodes rather oblong with rounded peaks, do not project far beyond hinge line. Anterior nodal complex consists of two nodes, separated by indistinct transverse depression. Anterodorsal node greater than anterocentral node. Anterocentral node closer to anterior margin than anterodorsal. Preadductorial node totally incorporated in anterodorsal node. Pseudovelum developed as low ridge or bend in juvenile specimens. Lateral surface reticulate, bases of lumina have pore clusters (see p. 155).

**Remarks**. — *Klimphores (K.) subplanus* sp. n. is similar in size and form to *Klimphores (K.) planus* SCHALLREUTER, from upper Viruan erratic boulders (SCHALLREUTER 1966, 1980a), but differs in having a slightly marked bipartition of the anterior nodal complex, and pseudovelum as a ridge in adult specimens.

**Distribution**. — In Mójca it occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis* and the lower part of the *Amorphognathus superbus* Zones, Middle Ordovician.

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**Klimphores (Klimphores) vannieri** sp. n.  
(Pls 45: 9–11; 51: 1–3; Text-fig. 10)

**Holotype**: ZPAL O.XXV/284.  
**Type horizon**: *Amorphognathus superbus* Zone, Late Ordovician.  
**Type locality**: Mójca, Holy Cross Mountains, Poland.  
**Derivation of the name**: In honour of Dr. Jean VANNIER from Lyon, France.

**Diagnosis**. — Valves up to 1.0 mm in length. Anterior cardinal corner more rounded and obtuse than posterior corner. Anterior nodal complex slightly divided into anterodorsal and anterocentral nodes; anterodorsal with indistinct preadductorial node. Posterior node oblong, projecting farther beyond hinge-line than anterior node.

**Material**. — 119 valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 10):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/244</td>
<td>0.77</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/283</td>
<td>0.83</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/284</td>
<td>0.67</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/455</td>
<td>0.79</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/457</td>
<td>0.81</td>
<td>0.54</td>
</tr>
</tbody>
</table>

**Description**. — Valves moderately high to moderately long and amplete. Hinge line straight and moderately long. Nodes with rounded peaks, slightly extending beyond hinge-line; posterior node extending farther than anterodorsal node. Anterior nodal complex slightly divided into anterodorsal
and anterocentral nodes; anterodorsal with slightly divided indistinct preadductorial node in posteroventral part of it. Anterocentral node close to anterior margin and smaller than anterodorsal. Posterior node oblong. Posterior and posteroventral surface flat. Pseudovelum forms prominent bend. Reversal of overlap occurs in this species. Reticulation moderately coarse, lumina with pore clusters (see p. 155).

**Remarks.** — *Klimphores (K.) vannieri* sp. n. is similar in form to the stratigraphically older *Klimphores (K.) subplanus* sp. n. but differs in having a much clearer bipartition of the anterior nodal complex and the development of an indistinct preadductorial node. The nodes project a smaller distance beyond the hinge line than in *K. (K.) subplanus.*

**Distribution.** — In Mójcza it occurs only in the upper part of the *Amorphognathus superbus* Zone, Late Ordovician.

Subgenus *Klimphores (Laterophores)* SCHALLREUTER, 1968

Type species: *Laterophores lateris* SCHALLREUTER, 1968.

*Klimphores (Laterophores) ansiensis* GAILITE, 1971

(Pl. 45: 1–3; Text-fig. 10)


**Material.** — 86 valves.

Dimensions (figured specimens, see also size dispersion in Text-fig. 10):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/273</td>
<td>0.59</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/425</td>
<td>0.58</td>
<td>0.32</td>
</tr>
<tr>
<td>ZPAL O.XXV/494</td>
<td>0.56</td>
<td>0.38</td>
</tr>
</tbody>
</table>

**Remarks.** — *Klimphores (L.) ansiensis* resembles *K. (L.) elevatus* JONES, from the Middle Ordovician of Great Britain (JONES 1987), but differs from it in lacking a convex posteroventral lobe and the anterior nodal complex is closer to the anterior margin of the valve.

**Distribution.** — In Mójcza it occurs in the *Amorphognathus variabilis* Zone, Early Ordovician, and in the lowermost *Pygodus serra* Zone, Middle Ordovician.

In Latvia it occurs in the Early Ordovician and the lowermost Middle Ordovician.

*Klimphores (Laterophores) sp.*

(Pl. 45: 12–13)

**Material.** — 3 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/302</td>
<td>0.63</td>
<td>0.34</td>
</tr>
<tr>
<td>ZPAL O.XXV/303 broken</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description.** — Valves up to 0.7 mm long, subamplete. Cardinal corners slightly rounded. Hinge line long. Lateral surface moderately convex. Anterior nodal complex clearly separated into three parts—a oval anterodorsal node, round anterocentral node and small, round preadductorial node. Posterior node elliptical, strongly projecting beyond hinge-line. Pseudovelum bend-like. Fine surface reticulation poorly preserved.

**Remarks.** — *Klimphores (L.) sp.* resembles in the development of the anterior nodal complex *Klimphores (L.) varesei* VANNIER from the Llandeilo and Caradoc of the Ibero-Armorican Massiv (VANNIER 1986a) but differs in having a separated preadductorial node.

**Distribution.** — In Mójcza it occurs in the *Amorphognathus tvaerensis* Zone, Middle Ordovician.

Genus *Vaivanovia* SCHALLREUTER, 1966

Type species: *Vaivanovia hiddenseensis* SCHALLREUTER, 1966.
OSTRACODS OF THE MÔJCZA LIMESTONE

Vaivanovia hiddenseensis SCHALLREUTER, 1966

(Pl. 44: 1–2)


Material. — 4 poorly preserved valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/30</td>
<td>0.54</td>
<td>0.30</td>
</tr>
<tr>
<td>ZPAL O.XXV/228</td>
<td>0.65</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Distribution. — In Môjcza it occurs in the upper Amorphognathus tvaerensis and lower Amorphognathus superbus Zones, Middle Ordovician.

It occurs also in Backsteinkalk erratic boulders, upper Viruan, Middle Ordovician.

Genus Lubrznkiella gen. n.

Type species: Lubrzankiella minuta sp. n.

Derivation of the name: From Lubrzanka, a river near the type locality.

Diagnosis. — Small binodicope (less than 0.8 mm), nearly amplete. Two small nodes in front of S2 – cone like, small anterior node and preadductor node. Large node in centroventral region. Small spine on dorsal margin near anterior cardinal corner. Lateral surface weakly granulose.

Remarks. — Lubrznkiella gen. n. is similar to Regina SCHALLREUTER, 1983b. The new genus is distinguished by position of the centroventral node, lack of velum and presence of an anterodorsal spine.

Lubrznkiella minuta sp. n.

(Pl. 44: 3–5; Text-fig. 20)

Holotype: ZPAL O.XXV/125.

Type horizon: Pygodus serra Zone, Middle Ordovician.

Type locality: Môjcza, Holy Cross Mountains, Poland.

Derivation of the name: From Latin minutus – small, referring to the small size of specimens.

Diagnosis. — As for the genus.

Material. — 21 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/110</td>
<td>0.59</td>
<td>0.42</td>
</tr>
<tr>
<td>ZPAL O.XXV/125</td>
<td>0.75</td>
<td>0.42</td>
</tr>
<tr>
<td>ZPAL O.XXV/147</td>
<td>0.72</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Description. — Valves high, amplete to slightly preplete. Hinge-line moderately long. Cardinal corners rounded, both slightly greater than 90°. Domicilium most elevated in anterovenal region. Entire ventral margin convex. Anterior node cone-like (AN), near anterior margin, slightly above mid-height. Preadductor node small (PAN), rounded. Centroventral node large (VN), rounded, in front of mid-length. Small spine occurs on dorsal margin near mid-length or in smaller specimens near anterior cardinal corner. Sulcus indistinct (Text-fig. 20). Surface finely granulose in small specimens and nearly smooth in adult.

Remarks. — Lubrznkiella minuta sp. n. resembles Regina reginae SCHALLREUTER, 1983b from the upper Harr-juan erratic boulders, but differs from it in having an anterodorsal node and a large centroventral node.

Fig. 20.

Schematic diagram of lateral view of Lubrzankiella minuta gen. et sp. n.
**Distribution.** — In Mójcza it occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis* and lowermost *Amorphognathus superbus* Zones, Middle Ordovician.

Superfamily *Aechminacea* Bouček, 1936
Family *Circulinidae* Nackaja, 1966
Genus *Orechina* Krůta, 1968

Type species: *Orechina punctata* Krůta, 1968.

**Remarks.** — Species of *Orechina* up to now were known from the Late Ordovician of Bohemia (Krůta 1968), Middle Ordovician of Scania (Schallreuter 1980b) and Latvia (Gailite 1975; =*Parapyxion bernatiensis*). The taxonomic position of the genus was discussed by Schallreuter and Krůta (1987).

*Orechina krutai* sp. n.

(Pl. 44: 7–9)

Holotype: ZPAL O.XXV/300.
Type horizon: *Pygodus anserinus* Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: In honour of Dr. Miroslav Krůta from Prague.

**Diagnosis.** — Length up to 0.9 mm. Outline postplete to subamplete. S2 weakly developed. No bend between marginal and lateral surface. Surface of domicilium reticulate.

**Material.** — 175 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/78</td>
<td>0.76</td>
<td>0.50</td>
</tr>
<tr>
<td>ZPAL O.XXV/300</td>
<td>0.72</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/402</td>
<td>0.88</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**Description.** — Outline slightly postplete to subamplete. Greatest length up to 0.9 mm. Lateral surface flat, not forming bend with marginal surface. S2 weakly developed, comma-like. Lateral surface reticulate/punctate. Surface parallel to margins and dorsal border is smooth. No dorsal ridge.

**Remarks.** — *Orechina krutai* sp. n. resembles *Orechina procera* Schallreuter, from upper Viruan erratic boulders (Schallreuter 1980b) in character of the ornamentation but differs in having a weaker S2 and a flat lateral surface.

**Distribution.** — In Mójcza it occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis* and *Amorphognathus superbus* Zones, Middle and Late Ordovician.

Genus *Vogdesella* Baker, 1924

Type species: *Jonesella obscura* Ulrich, 1894.

*Vogdesella aequae* sp. n.

(Pl. 44: 10–12; Text-fig. 21)

Holotype: ZPAL O.XXV/481.
Type horizon: *Pygodus serra* Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin *aequus* – referring to the flat lateral surface.

**Diagnosis.** — Sulcus indistinct, comma-shaped. Elevations in front of and behind sulcus weakly developed. Macula poorly defined. Lateral surface flat.

**Material.** — 157 valves.

Dimensions (figured specimens):
**OSTRACODS OF THE MÓJCZA LIMESTONE**

**Fig. 21.** Schematic diagram of lateral view of *Vogdesella aequae* sp. n.

**Description.** — Valves small to medium sized. Outline distinctly postplete. Sulcus short, indistinct, comma-shaped. Preadductorial node (*N₁*) weakly developed. Posterior node (*N₂*) in form of weakly developed long elevation, continuous along posterior margin as weak bend between lateral and marginal surface (Text.-fig. 21). Lateral surface of valve flattened. Mark of adductor scar (macula) poorly defined, circular, lying at end of short sulcus (not recognizable in many specimens). No ornamentation has been observed.

**Remarks.** — *Vogdesella aequae* sp. n. resembles *Vogdesella subovata* (THORSLUND, 1948) from the Dalby formation (Sweden), in the outline and development of elevations, but differs in the flat lateral surface. *V. aequae* sp. n. slightly resembles *Mytoa klabava* SCHALLREUTER and KRŮTA, from the Early Ordovician of Bohemia (SCHALLREUTER and KRŮTA 1988) but differs in the strongly postplete lateral outline.

**Distribution.** — Abundant in the *Pygodus serra* Zone, Middle Ordovician.

Family uncertain
Genus *Pyxion* THORSLUND, 1948

Type species: *Primitia carinata* HADDING, 1913.

*Pyxion?* sp.

(Pl. 33: 12–13)

**Material.** — Three valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/45</td>
<td>0.95</td>
<td>0.61</td>
</tr>
<tr>
<td>ZPAL O.XXV/128</td>
<td>0.92</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**Description.** — Outline subamplete to slightly preplete. Dorsal margin straight and long. Anterior and posterior cardinal corners more than 90°. Anterior cardinal angle slightly larger than posterior. Anterior and posterior margins nearly equally curved. Ventral margin slightly convex. Short, faint sulcal depression near dorsal margin. Preadductoried node weakly developed. Moderately wide pseu- dovelum is developed along entire free margin. Lateral surface smooth.

**Remarks.** — Because of the small amount of material, the species is not named and its generic assignment remains uncertain. *Pyxion rekverensis* MEIDLA, 1986, and *Pyxion nitidum* SARV, 1963 from the Middle Ordovician of Estonia, resemble the new species in lateral outline and surface ornament, but *P.?* sp. differs from them in having a flatter lateral surface.

**Distribution.** — Rare in the *Amorphognathus superbus* Zone, Late Ordovician.

**Suborder Leiocopa** SCHALLREUTER, 1973

**Superfamily Aparchitacea** JONES, 1901

**Family Aparchitidae** JONES, 1901

**Genus Brevidorsa** NECKAJA, 1973


**Remarks.** — BERDAN (1982) and VANIER (1990) discussed *Brevidorsa* in details and compared its numerous species.
Brevidorsa limbata (SIDARAVICIENE, 1975)  
(Pl. 47: 1–3)

1986. Brevidorsa limbata (SIDARAVICIENE); SCHALLREUTER, Pl. 5: 9.  
1990. Brevidorsa limbata (SIDARAVICIENE); VANNIER, p. 105, Fig. 1, 2.  
1992. Brevidorsa limbata (SIDARAVICIENE); SIDARAVICIENE, p. 178, Pl. 44: 11, 12.  

Material. — 47 specimens, part of them internal moulds.  

Dimensions (figured specimens):  

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/16</td>
<td>0.72</td>
<td>0.61</td>
</tr>
<tr>
<td>ZPAL O.XXV/36</td>
<td>0.70</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXV/460</td>
<td>0.92</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Remarks. — Specimens from Mójca possess an adductor muscle field composed of 13–15 scars.  

Distribution. — In Mójca it occur in the Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis Zones, Middle-Ordovician.

Brevidorsa sp.  
(Pl. 47: 4)

Material. — One internal mould.  

Dimensions:  

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/116</td>
<td>0.98</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Remarks. — One specimen of Brevidorsa sp. has been found in the present material. Unfortunately the material is too badly preserved to be described in detail. The lateral outline is similar to that of Brevidorsa limbata, but differs in having an adductorial muscle field composed of a few tens of scars.  

Distribution. — It occurs only in the Pygodus serra Zone, Middle Ordovician.

Family Schmidtellidae NECKAJA, 1966  

Remarks. — The family Schmidtellidae as defined by BERDAN (1988) includes genera which are nonsulcate and with distinct central or subcentral umbones, so that the dorsum is epicline. The lack of sulcation in Schmidtella and other genera in the Schmidtellidae suggests according to BERDAN (1988) that this family should be placed in the suborder Leiocopa SCHALLREUTER, 1973 and the superfamily Aparenthicea JONES, 1901. SCHALLREUTER (1968c) placed the family Schmidtellidae in the suborder Eridostra can ADAMCZAK, 1961.

Genus Schmidtella ULRICH, 1892  

Type species: Schmidtella crassimarginata ULRICH, 1892.  

Schmidtella globosa sp. n.  
(Pl. 47: 5–6)

Holotype: ZPAL O.XXV/136.  
Type horizon: Pygodus serra Zone, Middle Ordovician.  
Type locality: Mójca, Holy Cross Mountains, Poland.  
Derivation of the name: From Latin globosus – round, referring to the subcircular lateral outline.  


Material. — 32 valves.  

Dimensions (figured specimens):  

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/136</td>
<td>0.92</td>
<td>0.68</td>
</tr>
<tr>
<td>ZPAL O.XXV/155</td>
<td>0.79</td>
<td>0.59</td>
</tr>
</tbody>
</table>

**Remarks.** — *Schmidtella globosa* sp. n. resembles *Schmidtella fragosa* NECKAJA, from the Middle Ordovician of the Pskov region (NECKAJA 1966) in the similar outline of the carapace, but differs in having a more rounded outline. It is similar to the N-American species *Schmidtella minuta* HARRIS, 1957 and *Schmidtella affinis* ULRICH, 1894. It differs from species of *Easchmidtella* SCHALLREUTER, 1967 in lacking an indication that it possesses a sulcament, which is considered diagnostic for the latter genus.

**Distribution.** — In Mőcza it occurs in the *Pygodus serra*, *Pygodus anserinus* and *Amorphognathus tvaerensis* Zones, Middle Ordovician.

---

Suborder **Eridostraca** ADAMCZAK, 1961
Family **Conchoprimitiidae** HENNINGSMOEN, 1953
Genus **Conchoprimitia** ØPIK, 1935

Type species: *Conchoprimitia gammae* ØPIK, 1935.

*Conchoprimitia*? *ventroincisurata* (HESSLAND, 1949)
(Pl. 47: 11–13)

1949. *Conchoides ventroincisurata* sp. n.; HESSLAND, p. 172, Pl. 2: 8–9.

**Material.** — 90 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/122</td>
<td>0.83</td>
<td>0.49</td>
</tr>
<tr>
<td>ZPAL O.XXV/134</td>
<td>0.85</td>
<td>0.49</td>
</tr>
<tr>
<td>ZPAL O.XXV/410</td>
<td>0.83</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Remarks.** — According to JAANUSSON (1957) the so-called “non-leperditioioid group of Conchoides” (HESSLAND 1949), ought probably to be excluded from *Conchoprimitia* but more well preserved material and further studies are needed to answer this question.

**Distribution.** — In Mőcza it occurs in the *Amorphognathus variabilis* Zone, Early Ordovician. In Sweden *C.? ventroincisurata* occurs in the Early Ordovician of Siljan District.

*Conchoprimitia*? *modlinskii* sp. n.
(Pl. 47: 9–10)

Holotype: ZPAL O.XXV/131.

Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.

Type locality: Mőcza, Holy Cross Mountains, Poland.

Derivation of the name: In honour of Dr. Zdzislaw MODLIŃSKI from the State Geological Institute in Warsaw.

**Diagnosis.** — Carapace evenly convex, non-sulcate. Cardinal angles obtuse. Posterior margin slightly concave near posterior cardinal corner. Surface smooth.

**Material.** — 74 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/100</td>
<td>0.48</td>
<td>0.34</td>
</tr>
<tr>
<td>ZPAL O.XXV/131</td>
<td>0.79</td>
<td>0.54</td>
</tr>
</tbody>
</table>

**Description.** — Valves moderately and rather uniformly convex, highest convexity at about mid-length of valve. Cardinal corners rounded, both obtuse. Posterior cardinal corner field flattened. Posterior margin slightly concave near dorsal margin. No sulcal depression or very indistinct. Surface of valve smooth.
Remarks. — The taxonomic position of this species is unclear. It is similar in lateral outline to *Conchoprimitia* species but shows also similarities to other similar genera of Spinigeritidae and Circulinidae.

Distribution.— It occurs in the *Amorphognathus variabilis* Zone, Early Ordovician.

*Conchoprimitia? polonica* sp. n.

(Pl. 47: 14–16)

Holotype: ZPAL O.XXV/307.
Type horizon: *Amorphognathus variabilis* Zone, Early Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Poland.


Material. — 290 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/74</td>
<td>0.92</td>
<td>0.59</td>
</tr>
<tr>
<td>ZPAL O.XXV/108</td>
<td>1.15</td>
<td>0.83</td>
</tr>
<tr>
<td>ZPAL O.XXV/307</td>
<td>1.10</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Description. — Length up to at least 1.3 mm. Shape very high to high. Valves strongly convex, greatest width slightly below dorsal margin. Cardinal corners rounded, both obtuse. Sulcus indistinct, short. Preadductorial node weakly developed, forming round elevation in front of depression. Surface of valve smooth.

Remarks. — *Conchoprimitia? polonica* sp. n. differs rather considerably from the other species of the genus, and later studies may prove the necessity of removing it into a separate genus. In general outline it is similar to *Conchoprimitia leperditioidea* THORSLUND, 1940.

Distribution. — In Mójcza it occurs only in the *Amorphognathus variabilis* Zone, Early Ordovician.

Order Platyctica SARS, 1866
Suborder Cytherelliformes SKOGSBERG, 1920
Superfamily Kloedenellacea ULRICH et BASSLER, 1908
Family Monotiopleuridae GUBER et JAANUSSON, 1964
Genus Domaszewicella gen. n.

Type species: *Domaszewicella tridepressa* sp. n.
Derivation of the name: From Domaszewice – name of the village near the type locality.

Diagnosis. — Nonsulcate monotiopleurids; adult females with distinct domatium having three separate egg compartments in each valve.

Remarks. — *Domaszewicella* gen. n. shows some resemblance to *Primitiella* ULRICH, in lateral outline and poorly defined sulcal depression. It differs from this genus in having egg compartments in female valves. The round depressions on the inner side of the female valves occur also in other paleozoic platycopes such as *Karinautatia* SCHALLREUTER (see SCHALLREUTER 1978), *Lomatopisthia* GUBER and JAANUSSON (see GUBER and JAANUSSON 1964), *Glyptotichvinella* POSNER (see LUNDIN 1987; LUNDIN and VISINTAINER 1987). The functional morphology of the shell in platycope ostracods was discussed in detail by JAANUSSON (1985).

*Domaszewicella tridepressa* sp. n.

(Pl. 46: 10–17)

Holotype: ZPAL O.XXV/124.
Type horizon: *Pygodus serra* Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: The name is referring to the three internal depressions.

**Diagnosis.** — As for the genus.

**Material.** — 93 tecnomorphic and 20 female valves, some damaged.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/19</td>
<td>1.26</td>
<td>0.65</td>
</tr>
<tr>
<td>ZPAL O.XXV/114</td>
<td>1.04</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/124</td>
<td>0.77</td>
<td>0.43</td>
</tr>
<tr>
<td>ZPAL O.XXV/256</td>
<td>0.97</td>
<td>0.52</td>
</tr>
<tr>
<td>ZPAL O.XXV/288</td>
<td>0.88</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/308</td>
<td>0.86</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/403</td>
<td>0.92</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/407</td>
<td>0.92</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Description.** — Outline nearly amplete; anterior margin evenly rounded; posterior margin faintly curved. Posterior cardinal angle more than 90°, anterior cardinal angle considerably larger. Lateral surface smooth with very faint sulcal depression. In front of sulcal depression, near dorsal margin, small node is visible. Distinct supramarginal depression present along ventral margin of left valve, right valve lacks this structure. Contact groove inside left valve. Adult females posteriorly wider than males, with three oval to circular separate egg compartments in posterior part of each valve.

**Remarks.** — *Domaszewiczella tridepressa* gen. et sp. n. is characterized by the flat carapace in tecnomorphs and internal depressions in females. Its lateral outline is similar to that of *Primitiella* species (*P. mollis, P. minima, P. constricta*).

**Distribution.** — In Mőjcza it occurs in the *Pygodus serra* and lowermost *Pygodus anserinus* Zones, Middle Ordovician.

Genus *Primitiella* Ulrich, 1897

Type species: *Primitiella constricta* Ulrich, 1897.

*Primitiella mojczensis* sp. n.

(Pl. 46: 1–3)

Holotype: ZPAL O.XXV/414.

Type horizon: *Pygodus serra* Zone, Middle Ordovician.

Type locality: Mőjcza, Holy Cross Mountains, Poland.

Derivation of the name: From the type locality.

**Diagnosis.** — *Primitiella* with very poorly defined to obsolete sulcal depression. Distinct ventral cavity. Ornamentation consists of very faint reticulation.

**Material.** — 486 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/39</td>
<td>0.58</td>
<td>0.31</td>
</tr>
<tr>
<td>ZPAL O.XXV/414</td>
<td>0.81</td>
<td>0.38</td>
</tr>
<tr>
<td>ZPAL O.XXV/415</td>
<td>0.72</td>
<td>0.34</td>
</tr>
</tbody>
</table>

**Description.** — Outline is about rectangular. Dorsal margin straight and parallel to slightly concave ventral margin. Anterior margin more rounded than posterior margin. Anterior and posterior cardinal angles slightly greater than 90°. Poorly defined to obsolete sulcal depression. Dimorphism poorly recognised, heteromorphs more inflated posteriorly. Fine surface reticulation usually poorly preserved.

**Remarks.** — Since the material of *Primitiella mojczensis* sp. n. contains no closed carapaces, the strangular process and overlap of the valves is unknown for this species. However, this species is very similar to other *Primitiella* species, and therefore included in this genus. When more material, including closed carapaces, is available, this may need revision.

**Distribution.** — It occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerensis* and *Amorphognathus superbus* Zones, Middle and Late Ordovician.
Primitiella? sp.
(Pl. 46: 9)

Material. — 2 valves.

Dimensions (figured specimen):

\[
\begin{array}{cc}
\text{L} & \text{H} \\
\text{ZPAL O.XXV/160} & 1.39 & 0.77
\end{array}
\]

Remarks. — The material agrees in most respect with Domazsevicella tridepressa sp. n. However, as far as can be assessed, it is distinct from it in lacking egg compartments, larger overall size, and more ample outline. The lateral outline is similar to that in Primitiella species. More material is needed for the determination of this species.

Distribution. — It occurs in the Pygodus anserinus Zone, Middle Ordovician.

Genus Unisulcopleura Schallreuter, 1968

Type species: Unisulcopleura unisulcata Schallreuter, 1968.

Unisulcopleura reticulata sp. n.
(Pl. 46: 4–7)

Holotype: ZPAL O.XXV/72.
Type horizon: Amorphognathus variabilis Zone, Early Ordovician.
Type locality: Mójczâ, Holy Cross Mountains, Poland.

Derivation of the name: The name is referring to surface ornamentation.

Diagnosis. — Valves moderately high and strongly postplete. Cardinal angles greater than 90°. Sulcus short, straight, narrow. Fingerprint ornament in posterior part of valve, reticulate in anterior and central region.

Material. — 72 valves.

Dimensions (figured specimens):

\[
\begin{array}{cc}
\text{L} & \text{H} \\
\text{ZPAL O.XXV/160} & 0.53 & 0.32 \\
\text{ZPAL O.XXV/130} & 0.59 & 0.32 \\
\text{ZPAL O.XXV/411} & 0.81 & 0.41 \\
\text{ZPAL O.XXV/419} & 0.85 & 0.43
\end{array}
\]

Description. — Valves postplete in lateral outline. Greatest length of valve in mid-height, Greatest height posterior. Cardinal corners slightly rounded, both much greater than 90°, anterior angle more obtuse than posterior. Sulcus short, straight, rather narrow. Ventral margin slightly concave in middle part. Fingerprint ornament in posterior part of valve, reticulate in anterior and central region.

Remarks. — In lateral outline and ornamentation Unisulcopleura reticulata sp. n. is similar to Mytoa? expressoreticulata (Hessland), (cf. Schallreuter and Krūta 1988) but differs in lacking macula (muscle spot). It is also similar to Unisulcopleura weitschati Schallreuter from Middle Ordovician erratic boulders (Schallreuter 1987) but differs by a more postplete lateral outline.

Distribution. — It occurs in the Amorphognathus variabilis Zone, Early Ordovician.

Unisulcopleura? permulta sp. n.
(Pl. 47: 7–8)

Holotype: ZPAL O.XXV/85.
Type horizon: Amorphognathus variabilis Zone, Early Ordovician.
Type locality: Mójczâ, Holy Cross Mountains, Poland.

Derivation of the name: From Latin permultus — numerous.

Diagnosis. — Valves up to 0.9 mm long, rather high, strongly postplete. Cardinal corners slightly rounded, posterior corner angle greater than anterior. Sulcus slightly in front of mid-length, short. Valve surface reticulate in central reion, smooth near margins.

Material. — 315 valves.
Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/85</td>
<td>0.67</td>
<td>0.48</td>
</tr>
<tr>
<td>ZPAL O.XXV/102</td>
<td>0.83</td>
<td>0.47</td>
</tr>
</tbody>
</table>


**Remarks.** — *Unisulcopl eura? permulta* sp. n. differs from congeneric species by its more postplete outline. It is similar to *Primitiella kogerm anii* (Öpik) but differs in a longer dorsal margin, from *Primitiella moll i* (Bonnema) it differs in having a more rounded anterior margin.

**Distribution.** — It occurs in the *Amorphognath us variabil is* Zone, Early Ordovician.

*Unisulcopl eura?* sp. 1
(Pl. 46: 8)

**Material.** — 7 valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/286</td>
<td>0.95</td>
<td>0.50</td>
</tr>
</tbody>
</table>

**Description.** — Valves up to 1.00 mm long. Valve outline slightly postplete. Cardinal corners quite distinct, posterior more obtuse than anterior corner. Valves slightly convex. Sulcal depression indistinct developed in anterior dorsocentral region, does not reach hinge line. Preadductorial node weakly developed. Valve surface with fine fingerprint-like ornament.

**Remarks.** — *Unisulcopl eura?* sp. 1 resembles *Unisulcopl eura reticulata* sp. n. in lateral outline and weakly developed sulcal depression, but differs in a more postplete outline and the ornamentation of the valve. The outline of *U.? permulta* sp. n. is more postplete. *U.?* sp. 1 is similar to *Conchoprimitiella papilalata* Jones, from the Caradocian of the British Isles (Jones 1987) in having fingerprint-like ornament.

**Distribution.** — Rare in the *Amorphognath us variabil is* Zone, Early Ordovician.

*Unisulcopl eura?* sp. 2
(Pl. 28: 9)

**Material.** — 2 valves.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th>Specimen</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/165</td>
<td>1.10</td>
<td>0.63</td>
</tr>
</tbody>
</table>

**Description.** — Valve outline nearly amplete to slightly postplete. Dorsal margin long and straight. Anterior and posterior margins rounded, posterior margin higher than anterior. Cardinal angles greater than 90°, posterior corner angle more obtuse than anterior. Adductor sulcus short, narrow, not reaching dorsal margin. Preadductorial node round, small. Lateral surface reticulate.

**Remarks.** — *Unisulcopl eura?* sp. 2 differs from *Unisulcopl eura reticulata* sp. n. in the larger size of the carapace and a larger preadductorial node.

**Distribution.** — Only in the *Pygodus anserinus* Zone, Middle Ordovician.

**Order Podocopa** Sars, 1866

**Suborder Metacopa** Sylvester-Bradley, 1961

**Superfamily Bairdiocypri dae** Shaver in Benson et al., 1961 (Kozur, 1972)

**Family Krausellidae** Berdan in Benson et al., 1961

**Genus Rectella** Neckaja, 1958

Type species: *Mica inaequalis* Neckaja, 1952.
Rectella carinaspinata Schallreuter, 1972
(Pl. 48: 12-15)

1986. Rectella carinaspinata Schallreuter; Schallreuter, Pl. 7: 3.

Material. — 9 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Number</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXXV/179</td>
<td>0.72</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXXV/242</td>
<td>0.86</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXXV/272</td>
<td>0.88</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXXV/529</td>
<td>0.90</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Remarks. — Rectella galba Neckaja, from the Middle Ordovician of East European Platform (Neckaja 1958) differs from R. carinaspinata by having a smaller transverse and longitudinal convexity.

Distribution. — In Mójcza it occurs in the Amorphognathus superbus Zone, Late Ordovician. In N-Germany it occurs in Ojlemyrflint erratic boulders, Late Ordovician.

Genus Trianguloschmidtella Sarv, 1963
Subgenus Trianguloschmidtella (Rempesgrinella) Knüffer, 1968

Type species: Rempesgrinella hemiventrocosta Knüffer, 1968.


Trianguloschmidtella (Rempesgrinella) hemiventrocosta (Knüffer, 1968)
(Pls 48: 6; 50: 1–2)


Material. — 24 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th>Number</th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXXV/177</td>
<td>0.95</td>
<td>0.54</td>
</tr>
<tr>
<td>ZPAL O.XXXV/447</td>
<td>1.06</td>
<td>0.61</td>
</tr>
<tr>
<td>ZPAL O.XXXV/448</td>
<td>1.01</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Remarks. — Knüffer’s (1968) figure of T. (R.) hemiventrocosta is very similar to the specimens of T. (R.) hemiventrocosta illustrated herein, except that the cardinal corners of Knüffer’s specimens are less rounded, and the height is the same in the anterior and posterior parts. In specimens from Mójcza, it is slightly greater in the anterior part of the carapace. T. (R.) cf. hemiventrocosta from the Late Ordovician of Australia (Schallreuter 1988) has a ventral ridge just behind the mid-length of the valve.

Distribution. — In Mójcza it occurs in the Amorphognathus superbus Zone, Late Ordovician. In Thuringia it occurs in the Kalkbank (latest Caradoc or Ashgill).

Genus Pseudorayella Neckaja, 1960

Type species: Pseudorayella scala Neckaja, 1960.

Pseudorayella ovalis Neckaja, 1960
(Pl. 49: 9–10)


Material. — 40 valves, some internal moulds.

Dimensions (figured specimens):
Remarks. — *Pseudorayella* sp. aff. *ovalis* from the Lexington Limestone, Midle Ordovician of Kentucky (WARSCHAUER and BERDAN 1982) possesses a smaller overall size of the carapaces and smaller concavity of the ventral margin.

**Distribution.** — In Mójca it occurs in the *Pygodus serra* Zone, Middle Ordovician. In Baltoscandia it occurs in the Middle Ordovician.

Family **Bairdiocyprididae** SHAVER in BENSON et al., 1961

Genus **Medianella** NECKAJA, 1966

Type species: *Bythocypris aequa* STUMBUR, 1956.

**Medianella? pudica** sp. n.

(Pl. 49: 13–14)

Holotype: ZPAL O.XXX/305.

Type horizon: *Pygodus serra* Zone, Middle Ordovician.

Type locality: Mójca, Holy Cross Mountains, Poland.

Derivation of the name: From Latin *pudica* – modest.

**Diagnosis.** — Elongate, greatest width and height in posterior part. Dorsal and ventral margins subparallel. Anterior and posterior margins nearly equally curved.

**Material.** — 437 specimens, valves and internal moulds.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXX/120</td>
<td>0.77</td>
<td>0.38</td>
</tr>
<tr>
<td>ZPAL O.XXX/167</td>
<td>0.83</td>
<td>0.45</td>
</tr>
</tbody>
</table>

**Description.** — Lateral outline elliptical, dorsal margin straight to slightly convex, subparallel to ventral margin. Anterior and posterior margins nearly curved. Ventral margin straight to slightly concave. Slight ventral lappet on left valve at concavity of ventral margin. Greatest height and width slightly postmedian. Two stop ridges on internal side of larger left valve. Shell surface smooth.

**Remarks.** — The specimens are only questionably assigned to *Medianella*, because unfortunately, although more than 400 valves or internal moulds can be assigned to this taxon on the basis of their lateral outline, not one is sufficiently well preserved as closed carapaces to show the character of the overlap and the dorsum, most are either badly corroded or steinkerns. This species differs from others assigned to the genus in having subparallel dorsal and ventral margins and more equally curved anterior and posterior margins.

**Distribution.** — In Mójca it occurs in the *Pygodus serra, Pygodus anserinus, Amorphognathus tvaerenensis, and Amorphognathus superbus* Zones, Middle and Late Ordovician.

**Medianella? sp. 1**

(Pl. 49: 15)

**Material.** — 58 valves, some of them damaged.

Dimensions (figured specimen):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXX/231</td>
<td>0.63</td>
<td>0.41</td>
</tr>
</tbody>
</table>

**Remarks.** — Unfortunately specimens of *Medianella?* sp. 1 are too badly preserved to be described in detail. The lateral outline is similar to that in the stratigraphically younger *Medianella? pudica*, but differs in having much greater height in the posterior part of the valve. More material is needed for determination of this species.

**Distribution.** — It occurs in the *Amorphognathus variabilis* Zone, Early Ordovician.
Medianella? sp. 2
(Pl. 49: 11–12)

Material. — 6 valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/118</td>
<td>1.03</td>
<td>0.36</td>
</tr>
<tr>
<td>ZPAL O.XXV/161</td>
<td>1.13</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Remarks. — Medianella? sp. 2 differs from M.? sp. 1 and M.? pudica in having very long carapaces with parallel dorsal and ventral margins. Because of the small amount of material, the species is not named and its generic assignment remains uncertain.

Distribution. — Occurs only in the Pygodus anserinus Zone, Middle Ordovician.

Genus Longiscula Neckaja, 1958

Type species: Longiscula arcuaris Neckaja, 1958.

Longiscula? affluens sp. n.
(Pl. 49: 1–7)

Holotype: ZPAL O.XXV/127.
Type horizon: Pygodus sera Zone, Middle Ordovician.
Type locality: Mójcza, Holy Cross Mountains, Poland.
Derivation of the name: From Latin affluens — abundant, rich, referring to its abundance in some beds.

Diagnosis. — Elongate, greatest width in posterior part of carapace, dorsal margin broadly curved, ventral margin concave.

Material. — More than 1900 internal moulds or valves.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/5</td>
<td>0.95</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/25</td>
<td>1.75</td>
<td>1.10</td>
</tr>
<tr>
<td>ZPAL O.XXV/37</td>
<td>1.21</td>
<td>0.68</td>
</tr>
<tr>
<td>ZPAL O.XXV/43</td>
<td>1.10</td>
<td>0.63</td>
</tr>
<tr>
<td>ZPAL O.XXV/127</td>
<td>0.80</td>
<td>0.38</td>
</tr>
<tr>
<td>ZPAL O.XXV/140</td>
<td>1.61</td>
<td>0.61</td>
</tr>
<tr>
<td>ZPAL O.XXV/306</td>
<td>0.92</td>
<td>0.45</td>
</tr>
</tbody>
</table>


Remarks. — The specimens are only questionably assigned to Longiscula because none is sufficiently well preserved as a closed carapace to show the character of the overlap. This form is similar to Longiscula ovata Neckaja, 1966, but is relatively longer and the ventral margin is more concave.

Distribution. — It is abundant in the Pygodus sera, Pygodus anserinus, Amorphognathus tvaerensis, and Amorphognathus superbus Zones, Middle and Late Ordovician.

Family Balticellidae Schallreuter, 1968
Subfamily Steusloffinae Schallreuter, 1984
Genus Steusloffina Teichert, 1937

Type species: Steusloffina ulrichi Teichert, 1937.

Steusloffina sp.
(Pl. 48: 10–11)

Material. — 2 right valves.
Dimensions:

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/176</td>
<td>0.90</td>
<td>0.45</td>
</tr>
<tr>
<td>ZPAL O.XXV/281</td>
<td>0.88</td>
<td>0.40</td>
</tr>
</tbody>
</table>


Remarks. — The material probably represents a new species but more material is needed to confirm this. The specimens of Steusloffina from the present material resemble Steusloffina dilatata Meidla, 1983 from the Late Ordovician of Western Estonia, but differ from the latter by the shape of the posterior margin of the right valve. Steusloffina sp. also resembles Steusloffina radiculosa Neckaja, 1966 from the Middle Ordovician of Estonia in the outline of the valves. Steusloffina sp. differs from Steusloffina cuneata (Steusloff, 1895) and Steusloffina lintra Schallreuter, 1972 by the lack of spines.

Distribution. — It occurs only in the Amorphognathus superbus Zone, Late Ordovician.

Family uncertain
Genus Pinnatulites Hessler, 1949

Type species: Primitiella procera Kummerow, 1924.

Remarks. — Many taxonomic problems still exist with this genus. According to Hessler (1949) the genus should be placed in Aparchitidae, according to Sarv (1959) and Sidaraviciene (1992) in Leperditillidae, Hessler in Benson et al. (1961) placed Pinnatulites in Palaeocopida, Schallreuter (1979) in Bairdiacea and Schallreuter (1990) in Rectellidae. More well preserved material with preserved internal structures is needed to establish its taxonomic position.

Pinnatulites procera (Kummerow, 1924)

(Pl. 48: 1–5, Text-fig. 14)

1924. Primitiella procera sp. n.; Kummerow, p. 419, Pl. 20: 12.
1949. Pinnatulites procera (Kummerow); Hessler, p. 199, Pl. 4: 14–15.
1959. Pinnatulites procera (Kummerow); Sarv, p. 171, Pl. 30: 12–14.
1992. Pinnatulites procera (Kummerow); Sidaraviciene, p. 196, Pl. 51: 3 (here older synonymy).

Material. — 110 valves and internal moulds.

Dimensions (figured specimens):

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/149</td>
<td>0.68</td>
<td>0.43</td>
</tr>
<tr>
<td>ZPAL O.XXV/263</td>
<td>1.28</td>
<td>0.72</td>
</tr>
<tr>
<td>ZPAL O.XXV/422</td>
<td>1.60</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Remarks. — For a discussion on the surface ornament see p. 158.

Distribution. — In Mójcza it is restricted to the upper part of the Amorphognathus variabilis Zone, Early Ordovician. In Baltoscandia it is common in the Kunda Stage (Estonia, Lithuania, Latvia, Sweden, N Germany erratic boulders), Early Ordovician.

Superfamily uncertain
Family Condomyridae Schallreuter, 1977
Genus Condomyra Schallreuter, 1968

Type species: Condomyra brevinodata Schallreuter, 1968.

Condomyra reticulata Schallreuter, 1968

(Pl. 48: 7–9)

1977b. Condomyra reticulata Schallreuter; Schallreuter, Pl. 4: 1–2.
1986. Condomyra reticulata Schallreuter; Schallreuter, Pl. 8: 10.

**Material.** — 22 valves.

Dimensions (figured specimens):  

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZPAL O.XXV/99</td>
<td>0.36</td>
<td>0.24</td>
</tr>
<tr>
<td>ZPAL O.XXV/264</td>
<td>0.45</td>
<td>0.27</td>
</tr>
<tr>
<td>ZPAL O.XXV/266</td>
<td>0.50</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Remarks.** — Specimens from Mójcza have poorly preserved marginal structures. The inner lamella is not visible.

**Distribution.** — In Mójcza it occurs in the *Pygodus serra*, *Pygodus anserinus* and *Amorphognotus tvaerensis* Zones, Middle Ordovician. In N Germany it occurs in Öjlemyrflint erratic boulders, Late Ordovician.

**REFERENCES**

ADAMCZAK, F. 1968. Palaeocopida and Platycopida (Ostracoda) from Middle Devonian rocks in the Holy Cross Mountains, Poland. — *Stockholm Contributions in Geology* 17, 1–109.


Krütz, M. 1968. Orechina n. g. (Ostracoda, Crustacea) from the Upper Ordovician of Bohemia. — Casopis pro Mineralogii a Geologii 13, 55–62.


Schallreuter, R. 1966. Drepanellacea (Ostracods, Beyrichida) aus mittelordovizischen Backsteinkalkgeschieben I. Klimphores planus g. n. sp. n. und Vaivanovia hiddenseensis g. n. sp. n. — Berichte der Deutschen Gesellschaft für Geologische Wissenschaften (A) 11, 393–402.


Number of specimens in each sample in Mójca section.

Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Amorphognathus variabilis Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>117</td>
</tr>
<tr>
<td>Ampletocilina priscina</td>
<td>1</td>
</tr>
<tr>
<td>Lembitosarrella sp.</td>
<td>2</td>
</tr>
<tr>
<td>Laccocilina (L.) berdanae</td>
<td>2</td>
</tr>
<tr>
<td>Durningia? aculeata</td>
<td>-</td>
</tr>
<tr>
<td>Eochilina? sp.</td>
<td>-</td>
</tr>
<tr>
<td>Gryphiswaldensia angustivelata</td>
<td>-</td>
</tr>
<tr>
<td>Otraczezia bulbata</td>
<td>1</td>
</tr>
<tr>
<td>Uhakiella perrara</td>
<td>2</td>
</tr>
<tr>
<td>Uhakiella sp. 1</td>
<td>-</td>
</tr>
<tr>
<td>Mójczella polonica</td>
<td>5</td>
</tr>
<tr>
<td>Quadritia? sp.</td>
<td>-</td>
</tr>
<tr>
<td>Rakverella (P.) antica</td>
<td>2</td>
</tr>
<tr>
<td>Rigidella dubia</td>
<td>-</td>
</tr>
<tr>
<td>Telegraphia prima</td>
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OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

PLATE 25

**Duringia? aculeata** sp. n. ............................................. 166

Fig. 1. Tecnomorphic right valve, ZPAL O.XXV/82, x 105, sample MA-34.
Fig. 2. Tecnomorphic right valve; holotype ZPAL O.XXV/66, x 105, sample MA-34.
Fig. 3. Heteromorphic right valve (broken dorsally), ZPAL O.XXV/199, x 42, sample MA-118.

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Fig. 4. Tecnomorphic right valve (broken posteriorly), ZPAL O.XXV/462, x 70, sample MA-57.
Fig. 5. External mould of tecnomorphic valve, ZPAL O.XXV/463, x 70, sample MA-57.

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Fig. 6. Heteromorphic right valve, ZPAL O.XXV/192, x 52, sample MA-43.

**Rigidella dubia** sp. n. .................................................. 179

Fig. 7. Tecnomorphic right valve, ZPAL O.XXV/301, x 70, sample MA-118.
Fig. 8. Tecnomorphic right valve, holotype ZPAL O.XXV/227, x 70, sample MA-118.

**Platybolbina (Reticulobolbina)** sp. .................................. 161

Fig. 9. Tecnomorphic left valve, ZPAL O.XXV/7, x 32, sample MA-93.

**Hesperidella posterospinata** sp. n. ................................. 162

Fig. 10. Tecnomorphic left valve, ZPAL O.XXV/482, x 70, sample MA-46.
Fig. 11. Tecnomorphic left valve, holotype ZPAL O.XXV/166, x 105, sample MA-55.
Fig. 12. Tecnomorphic right valve, ZPAL O.XXV/81, x 105, sample MA-66.

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Fig. 13. Female right valve, ZPAL O.XXV/290, x 105, sample MA-118.
Fig. 14. Tecnomorphic left valve, holotype ZPAL O.XXV/193, x 52, sample MA-38.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

PLATE 26

*Laccochilina (Laccochilina) berdaneae* sp. n. .................................................. 165

Fig. 1. Tecnomorphic right valve, holotype ZPAL O.XXV/471, × 70, sample MA-118.
Fig. 2. Tecnomorphic right valve, ZPAL O.XXV/472, × 52, sample MA-118.
Fig. 3. Tecnomorphic (Juv.) left valve, ZPAL O.XXV/129, × 98, sample MA-37.

*Piretella oepiki* THORSUND, 1940 ................................................................. 162

Fig. 4. Female valve, lateral view of velum, ZPAL O.XXV/515, × 105, sample MA-46.
Fig. 5. Tecnomorphic left valve, ZPAL O.XXV/164, × 42, sample MA-58.
Fig. 6. Female left valve, ZPAL O.XXV/96, × 35, sample MA-55.
Fig. 7. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/449, × 87, sample MA-99.

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Fig. 8. Tecnomorphic right valve, ZPAL O.XXV/451, × 77, sample MA-99.
Fig. 9. Tecnomorphic right valve, ZPAL O.XXV/241, × 105, sample MA-99.

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Fig. 10. Tecnomorphic right valve, holotype ZPAL O.XXV/86, × 70, sample MA-46.
Fig. 11. Tecnomorphic right valve, ZPAL O.XXV/526, × 105, sample MA-54.

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Fig. 12. Tecnomorphic right valve, holotype ZPAL O.XXV/196, × 52, sample MA-120.
Fig. 13. Female valve, ventral view of velum, ZPAL O.XXV/465, × 87, sample MA-120.
Fig. 14. Female valve (broken), ventral-oblique view of velum and base of crest, ZPAL O.XXV/420, × 70, sample MA-118.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMSKA: OSTRACODS OF THE MOJCZA LIMESTONE

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Piretella oepiki THORSLUND, 1940 .................................................. 162

Ornamentation of the surface.

Fig. 1. Lateral view, ZPAL O.XXV/164, x 48, sample MA-58.
Fig. 2. External mould, ZPAL O.XXV/248, a x 120, b x 400, sample MA-58.
Fig. 3. External mould, ZPAL O.XXV/444, a x 48, b x 240, sample MA-54.
Fig. 4. External mould, ZPAL O.XXV/450, a x 80, b x 240, sample MA-99.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

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_Lembitsarvella_ sp. ................................................................. 165

Fig. 1. Tecnomorphic left valve, ZPAL O.XXV/292, x 70, sample MA-37.
Fig. 2. Tecnomorphic left valve, broken posterodorsally, ZPAL O.XXV/429, x 70, sample MA-127.
Fig. 3. Tecnomorphic right valve, broken posteroventrally, ZPAL O.XXV/421, x 70, sample MA-120.
Fig. 4. Tecnomorphic valve, ventral view of velar structure, ZPAL O.XXV/452, x 140, sample MA-37.

_Lembitsarvella polonica_ gen. et sp. n. ........................................ 164

Fig. 5. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/438, x 52, sample MA-54.
Fig. 6. Tecnomorphic right valve, holotype ZPAL O.XXV/163, x 42, sample MA-58.
Fig. 7. Tecnomorphic left valve, ZPAL O.XXV/35, x 52, sample MA-56.
Fig. 8. Tecnomorphic right valve, ZPAL O.XXV/54, x 35, sample MA-82.

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Fig. 9. Left valve, ZPAL O.XXV/165, x 70, sample MA-59.

_Tvaerfellidae_ sp. A ................................................................. 177

Fig. 10. Tecnomorphic right valve, ZPAL O.XXV/91, x 70, sample MA-57.
Fig. 11. Heteromorphic right valve, broken posteriorly, ZPAL O.XXV/222, x 70, sample MA-59.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMPSKA: OSTRACODS OF THE MÓICZA LIMESTONE

PLATE 29

*Lembitsarvelle polonica* gen. et sp. n. ................................. 164

Fig. 1. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/433, × 52, sample MA-59.
Fig. 2. Tecnomorphic (Juv.) left valve, ZPAL O.XXV/430, a lateral view, × 52; b velar structure, × 210, sample MA-59.
Fig. 3. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/296, × 52, sample MA-58.
Fig. 4. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/295, × 52, sample MA-58.
Fig. 5. Tecnomorphic (Juv.) right valve, ZPAL O.XXV/293, a × 52; b × 140, sample MA-58.
Fig. 6. Female valve (broken), ventral view, ZPAL O.XXV/188, × 52, sample MA-59.
Fig. 7. Female valve (broken), ventral view, ZPAL O.XXV/439, × 52, sample MA-86.
Fig. 8. Tecnomorphic valve (broken), velar structure, ZPAL O.XXV/435, × 210, sample MA-58.
Fig. 9. Pre-adult female valve, ventral view, ZPAL O.XXV/298, a × 42; b × 140, sample MA-55.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

PLATE 30

*Lembitsarvella polonica* gen. et sp. n. ........................................ 164

Fig. 1. Tecnomorphic right valve, ZPAL O.XXV/12, × 42, note that the chambers in the dorsal plica are filled with phosphate, sample MA-82.

Fig. 2. Female left valve, internal mould (partly damaged), ZPAL O.XXV/483, a × 35; b detail of 2a showing the chambers in the dorsal plica filled with phosphate, × 105, sample MA-46.

Fig. 3. Internal view of fragment of female valve, showing the internal openings of the tubules, ZPAL O.XXV/474, × 70, sample MA-46.

Fig. 4. Internal view of tecnomorphic valve, showing the internal openings of the tubules, ZPAL O.XXV/466, × 50, sample MA-55.

Fig. 5. Internal view of juvenile valve, showing the internal openings of the tubules, ZPAL O.XXV/473, × 70, sample MA-46.

Fig. 6. Internal view of tecnomorphic valve, showing the tubules filled with phosphate, ZPAL O.XXV/477, × 35, sample MA-84.

Fig. 7. Internal view of tecnomorphic valve, showing the tubules filled with phosphate, ZPAL O.XXV/441, × 70, sample MA-85.

Fig. 8. Tecnomorphic left valve, showing the detail of the velum, note the border crest parallel to the velar edge, ZPAL O.XXV/440, × 70, sample MA-84.

Fig. 9. Ventral view of female valve, showing the Dolon, note the four parallel ridges on the Dolon, ZPAL O.XXV/478, a × 28; b detail of 9a, note the tubules filled with phosphate, × 105, sample MA-85.
OLEMSKA: OSTRACODS OF THE MÓJČZA LIMESTONE

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Lembitsarvella polonica gen. et sp. n. .......................... 164

Fig. 1. Tecnomorphic left valve, ZPAL O.XXV/432, a × 52; b detail of 1a showing the granular ornamentation on the surface of the domicilium, × 210, sample MA-59.

Fig. 2. Tecnomorphic valve, ventral view, ZPAL O.XXV/434, a × 70; b detail of 2a, showing the granular ornamentation on the surface, partly destroyed, × 210; c detail of 2a, × 700, sample MA-58.

Fig. 3. Tecnomorphic valve, damaged, ZPAL O.XXV/431, a × 70; b transverse section through phosphate lining showing the granular layer, × 105; c detail of 3b, × 350, sample MA-59.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

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Lembitsarvella polonica gen. et sp. n. .................................................. 164

Microornamentation of the surface.

Fig. 1. Left valve, lateral view, ZPAL O.XXV/163, × 48, sample MA-58.
Fig. 2. Detail of ornamentation, ZPAL O.XXV/523, × 240, sample MA-58.
Fig. 3. External mould, ZPAL O.XXV/162, a × 480; b × 800, sample MA-58.
Fig. 4. External mould, ZPAL O.XXV/476, a × 36; b × 160, sample MA-84.
Fig. 5. External mould, ZPAL O.XXV/524, × 120, sample MA-58.
Fig. 6. External mould, ZPAL O.XXV/469, × 160, sample MA-58.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

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Ampletochilina priscina sp. n. .................................................. 160
Fig. 1. Tecnomorphic left valve, ZPAL O.XXV/504, × 70, sample MA-120.
Fig. 2. Female right valve (broken posteriorly), holotype ZPAL O.XXV/418, × 70, sample MA-120.
Fig. 3. Female right valve (broken posterodorsally), ZPAL O.XXV/505, × 70, sample MA-117.

Swantina schallreuteri sp. n. .................................................. 160
Fig. 4. Tecnomorphic left valve, ZPAL O.XXV/51, × 70, sample MA-82.
Fig. 5. Female right valve, holotype ZPAL O.XXV/62, a lateral view; b lateroventral view, × 51, sample MA-58.
Fig. 6. Female left valve, internal lateral view, ZPAL O.XXV/509, × 70, sample MA-60.
Fig. 7. Female left valve, ZPAL O.XXV/510, × 52, sample MA-84.
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OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

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Fig. 2. Left valve, ZPAL O.XXV/273, × 105, sample MA-120.
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Fig. 14. Tectomorphic right valve, ZPAL O.XXV/19, × 42, sample MA-48.
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Fig. 15. Right valve, ZPAL O.XXV/179, x 105, sample MA-99.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE
OLEMPSKA: OSTRACODS OF THE MÓICZA LIMESTONE

PLATE 49

Longiscula? affluens sp. n. .......................... . 202
Fig. 1. Right valve, ZPAL O.XXV/37, x 70, sample MA-56.
Fig. 2. Left valve, ZPAL O.XXV/43, x 70, sample MA-56.
Fig. 3. Right valve, ZPAL O.XXV/306, x 70, sample MA-52.
Fig. 4. Left valve, ZPAL O.XXV/25, x 30, sample MA-55.
Fig. 5. Right valve, holotype ZPAL O.XXV/127, x 70, sample MA-46.
Fig. 6. Internal mould of right valve, ZPAL O.XXV/5, x 70, sample MA-56.

Pseudorayella ovalis Neckaja, 1960 .......................... . 200
Fig. 7. Internal mould of right valve, ZPAL O.XXV/140, x 70, sample MA-70.
Fig. 8. Left valve, ZPAL O.XXV/112, x 90, sample MA-46.
Fig. 9. Internal view of right valve, ZPAL O.XXV/167, x 70, sample MA-44.
Fig. 10. Internal mould of right valve, ZPAL O.XXV/123, x 87, sample MA-46.

Medianella? sp. 2 ....................................... . 202
Fig. 11. Internal mould of right valve, ZPAL O.XXV/118, x 70, sample MA-56.
Fig. 12. Internal mould of left valve, ZPAL O.XXV/161, x 70, sample MA-58.

Medianella? pudica sp. n. ............................... . 201
Fig. 13. Internal mould of left valve, note the stop ridges, ZPAL O.XXV/120, x 87, sample MA-52.
Fig. 14. Internal view of left valve, holotype ZPAL O.XXV/305, a x 70; b detail of 14a, showing two stop ridges, x 105, sample MA-51.

Medianella? sp. 1 ....................................... . 201
Fig. 15. Right valve, ZPAL O.XXV/231, x 105, sample MA-118.
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PLATE 50

Trianguloschmidtella (Rempesgrinella) hemiventrocosta (KNUPFER, 1968) . . 200

Phosphate fillings of normal pore canals.
Fig. 1. Right valve, ZPAL O.XXV/448, a × 80; b detail of la, × 240, sample MA-99.
Fig. 2. ZPAL O.XXV/447, × 120, sample MA-99.

Lembitsarvelle polonica gen. et sp. n. . . . . . . . . . . . . . . . . . . . . . . . . . . . . 164

Phosphate fillings of pore canals in ventromarginal region.
Fig. 3. ZPAL O.XXV/498, a × 160; b × 480, sample MA-47.
Fig. 4. ZPAL O.XXV/475, × 240, sample MA-47.
OLEMPSKA: OSTRACODS OF THE MÓJČZA LIMESTONE
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE

PLATE 51

*Klimphores (Klimphores) vannieri* sp. n. .... 189

Phosphate fillings of pore canals.

Fig. 1. ZPAL O.XXV/455, a x 104; b x 800; c x 240, sample MA-99.
Fig. 2. ZPAL O.XXV/457, x 400, sample MA-99.
Fig. 3. ZPAL O.XXV/456, a x 96; b x 400; c x 240, sample MA 99.
OLEMPSKA: OSTRACODS OF THE MÓJCZA LIMESTONE